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TOME XXXVIII

(Fascicule 1)

Session 1955 - 1956



LE CAIRE
IMPRIMERIE COSTA TSOUMAS & CO.
R.A.U.

INSTITUT D'EGYPTE

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فنية . وسيرسل لكم ببريد لاحق .

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Technical reasons have delayed the issuing of Vol. XXXVIII, part II, which will follow later.

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L'IMPORTANCE DES STATUES GRECQUES DU SERAPEUM DE MEMPHIS (1)

par

CHARLES PICARD,

Membre de l'Académie des Inscriptions et Belles Lettres.

Au moment où paraît, sous la signature de M. J.-Ph. Lauer et la mienne, une étude générale consacrée aux statues que Mariette dégagea il y a plus d'un siècle à Saqqarah, il n'est ni trop tôt ni trop tard pour marquer l'importance de la découverte mise aujourd'hui à la disposition des savants et du public.

On connaît ces documents, conservés non loin d'ici, sur place, et qui resteront là où ils ont été désensablés. M. P.-Ph. Lauer s'occupe en ce moment à assurer leur protection et leur présentation. Au vrai, le sort des œuvres dues aux travaux des fouilles de Mariette a quelque chose d'exceptionnel. La mise au jour date de plus d'un siècle ; et pourtant, malgré les efforts faits en 1939 par R. Macramallah et le Service des Antiquités d'Egypte, c'est seulement après cette année qu'il sera permis de mesurer l'importance des résultats. On a marqué ailleurs les étapes de cette reconquête, sur laquelle il n'est donc pas besoin de revenir. La progression de nos connaissances se poursuit encore puisque depuis notre commun livre de 1955, M. J.-Ph. Lauer a pu retrouver et réunir certains documents nouveaux ; de ceux-ci, il sera fait état dans notre *Rapport* destiné aux *Annales du Service des Antiquités* (2), et qui a été élaboré en même temps que la publication présentée en France par l'Institut d'Art de l'Université de Paris.

Les statues grecques du « Serapeum » de Memphis — je garde ici à dessein la forme primitive du nom par lequel Mariette désigna le sanctuaire qu'il déblayait (3) — se présentent à nous

(1) Communication présentée en séance du 7 novembre 1955.

(2) En cours de rédaction.

(3) En fait, ce mot, de forme inutilement latine, gagnerait à être remplacé aujourd'hui par le nom, plus correct, de « Sarapieion ».

désormais comme des documents d'un intérêt triple : *historique, artistique, religieux*. Je voudrais le faire paraître brièvement.

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L'intérêt proprement historique apparaît d'abord.

Tout le monde connaissait l'effort politique et religieux tenté par Ptolémée Ier, fils de Lagos, au Delta d'Egypte, après qu'il eût enfermé au Sêma la dépouille mortelle d'Alexandre le Grand. Ptolémée Ier, dit plus tard Ptolémée Sôter, n'était pas seulement un bon général d'Alexandre, mais un historien avisé, autant que diplomate. Il a compris aussitôt l'avantage que devait procurer à l'Egypte une fusion politique et religieuse entre les Macédoniens et les habitants autochtones du pays. D'un arrangement de cette sorte dépendait la paix et la prospérité. De là vint, entre autres mesures, la création, réglée par la cour des Lagides, d'un dieu nouveau, Sarapis ; un grand sculpteur grec, Bryaxis, fut chargé de réaliser la première effigie, du nouveau dieu, pathétique et colossale, accostée d'un Cerbère égyptisant. Quelques petits bronzes grecs du Musée du Caire nous en conservent encore plus ou moins l'image réduite (voir pl. I) ; des marbres aussi, en plus grande taille.

Or, on le voit maintenant, c'est bien à Memphis, « *Veteris Ægypti columen* », comme le marquent les *Histoires* de Tacite (4, 80-84) que fut créée l'image du dieu nouveau, pour le Serapeum ; à Memphis aussi, lieu désigné par Alexandre qui y sacrifia, s'est opéré le partage des pouvoirs entre Sarapis et le Dionysos macédonien. Ces faits sont inscrits dans l'imagerie plastique des parages du *Dromos,* menant aux cryptes des Apis : lieu de passage préparé de date très ancienne pour les courses rituelles du Pharaon et du bovidé sacré. Dionysos, qui avait inspiré par une épiphanie nocturne (cf. Plutarque et Tacite), sous la forme d'un bel adolescent, puis de la traditionnelle « colonne de feu », l'intronisation du nouveau dieu égypto-grec de Memphis, devait déléguer au Sarapis d'Egypte une partie de ses pouvoirs de divinité chthonienne, protectrice des morts. L'arrangement fut savamment mis en œuvre par les « conseillers cultuels » de Ptolémée Ier : Manéthon de Sebennytos, du côté de l'Egypte, l'hiérophante Timothéos d'Eleusis, du côté grec : mais on doit aussi tenir grand compte, désormais, de l'action probable de Démétrios

de Phalère, qui figure à l'Exèdre des Poètes et des Sages. Cet homme d'état grec — orateur et poète — chassé d'Attique après 307, était venu se réfugier en Egypte où Ptolémée Ier l'accueillit. Guéri par Sarapis d'une menace de cécité, il consacra son art d'hymnographe au nouveau dieu, et enrichit ainsi, dans un sens hellénisant, le recueil des textes sacrés, hymnes et prières.

Grâce aux découvertes de Mariette, nous avons le témoignage, sur le terrain, des dates des changements politiques et religieux qui survinrent. Dans l'Hémicycle des Poètes et des Sages, Démétrios de Phalère figure auprès de Pindare ; il est appuyé sur un « hermès » de Sarapis, qui est fort proche, comme on le pressent, de la création perdue de Bryaxis (chevelure laineuse à mèches superposées, décor végétal du *modius*) (voir pl. II). Or, la présence de Démétrios de Phalère n'aurait pas été tolérée à Memphis après la mort de Ptolémée Ier, puisque l'Athénien fut exilé en Haute-Egypte, aussitôt après l'avènement de Ptolémée II Philadelphe. Ainsi le groupe des statues encadrant Homère est-il antérieur à 283 av. J.C.

Nous sommes, d'autre part, libérés de toute incertitude au sujet de la chronologie des actes religieux décidés par les quatre premiers Lagides, puisque les tablettes de consécration des dépôts de fondation angulaires du Serapeum d'Alexandrie, et de l'un de ses temples (pour Harpocrate) ne mentionnent que Ptolémée III et Ptolémée IV (celui-ci pour le petite temple d'Harpocrate).

L'antériorité des installations de Memphis sur celles d'Alexandrie est donc établie.

On avait gardé à Dionysos, aux parages du *Dromos,* les aspects les plus grecs de son activité : comme inspirateur et protecteur des intellectuels, suzerain littéraire, à l'Hémicycle (pl. III, 1) ; comme jeune dieu sauveur des âmes, chevauchant symboliquement les monstres et les fauves, selon la tradition d'Egypte et de Grèce, dans le *Dromos* même.

Afin de concevoir l'importance historique des statues-portraits de l'Exèdre, groupées autour d'un Homère couronné de lierre (à corymbes), et de celles du *Dromos* (Dionysos et les animaux), il suffit de penser à l'étonnement encore éprouvé par Ad. Erman, longtemps le meilleur connaisseur de la religion égyptienne antique. Ayant vu les dessins de Mariette, grâce à U. Wilcken (1907), il s'étonnait de la présence, au Serapeum de

Memphis, des grandes gloires littéraires et artistiques de la Grèce : « Dieu sait ce qu'ils allaient chercher dans la société panachée du lieu de sépulture des Apis ! » Mais il oubliait alors qu'Alexandre avait honoré ce même lieu de joutes et concours, et qu'en Grèce, dès le temps de l'Académie de Platon, la méditation philosophique s'installait déjà volontiers près des nécropoles. En fait, l'Hémicycle de Memphis, de Pindare à Platon, est tout bruissant de rappels et d'allusions dionysiaques : nous l'avons montré dans notre livre. Et il est à sa place attendue dans une nécropole sacrée.



La remise au jour, complétée peu à peu, des documents du Serapeum de Saqqarah, est aussi un événement pour l'histoire de l'art, puisque ces découvertes nous ont révélé la première école de sculpture *en calcaire,* de l'art « alexandrin ». Il y a là une reprise, importante à connaître, de la plus vieille tradition locale, remontant à la troisième dynastie pour le moins : la sculpture en calcaire fut adoptée d'abord par les sculpteurs grecs des Lagides, et notamment par ce Dionysios (ou Dionysiadès ?) qui avait signé dans l'Exèdre, au dossier de la statue assise de Pindare, la première rencontrée par Mariette (1)

Pour le reste, on constate aussi l'influence prépondérante de Lysippe, qui était venu en Egypte comme sculpteur officiel du jeune conquérant macédonien. Ce qui apparait, selon cette tendance, c'est un art vigoureux et réaliste, tout autre chose donc que ce qu'on eût pu escompter de la pseudo- « *mièvrerie* » (?) si complaisamment attribuée dans les livres à l'art dit « galant » des « Alexandrins ». Au contraire, on a affaire à un style monumental, soucieux des masses constructrices, aussi bien que du petit détail significatif (siège de Pindare, pl. IV, imitant le siège en fer du *manteion* de Delphes, lyre de concours ; cubes éducatifs de Protagoras, baguette de Thalès ; sceptre royal à nodosités d'Héraclite).

On ne peut reprendre ici en détail l'analyse des œuvres : elle fait comprendre comment le lot des statues-portraits monumentales de l'Exèdre, groupées autour d'Homère, a conquis une

(1) Cette signature, vue par Mariette, a presque disparu.

renommée qui a porté jusqu'à Rome, naturellement ; mais aussi, ainsi que nous l'avons montré, elle a traversé les temps médiévaux et modernes : jusqu'à la *Divine Comédie* de Dante Alighieri, p. ex., jusqu'aux Apothéoses d'Homère de Raphaël et d'Ingres, etc...

Probablement, imité déjà au Serapeum d'Alexandrie, consécration de Ptolémée III — le groupe de statues-portraits de l'Exèdre a déterminé la composition de mosaïques instructives, dont la date se marque par les détails. Deux d'entre elles, déjà connues, nous ont aidés pour l'interprétation des figures :

a) celle de Torre Annunziata (Musée de Naples), la plus ancienne, qui avait été interprétée d'abord à tort comme une réunion des « Sept Sages » chez Périandre, tyran de Corinthe ;

b) celle d'Umbra Sarsina (Rome, Villa Albani, pl. III, 2) postérieure à la mort de Démétrios de Phalère, puisqu'on y voit déjà l'hymnographe de Sarapis tenant en mains le serpent dont il fut la victime en Haute-Egypte, après sa disgrâce (sous Ptolémée II Philadelphe) et son exil. Le thème de Démétrios de Phalère et de son « aspic » se retrouve aussi sur un des *skyphoi* d'argent de Boscoreale (gobelet dit des « squelettes »), et sur le vase de bronze d'Herstal (Musée de Bruxelles).

On peut dire qu'aucun monument, plus que l'Hémicycle du Serapeum, n'a eu de notoriété à l'époque hellénistique. Nul autre ne pourrait faire, d'autre part, plus d'honneur à la civilisation (?), qui s'est développée en Egypte à l'époque des Lagides, débordant largement le Proche-Orient méditerranéen.

Le second groupe des statues retrouvées, en calcaire aussi, celles qui bordaient le *Dromos,* n'est pas moins digne d'attention. Les découvertes de Mariette peuvent être maintenant reclassées, et cela compense un peu nos pertes, car certains groupes ont souffert. On a perdu, en particulier, les têtes de Dionysos adolescent, presque enfant, si importantes pour l'interprétation de ce lot de statues *cultuelles.* Le groupe de Dionysos adolescent avec les animaux sacrés était placé plus près de l'entrée des cryptes des Apis, en face de deux petits édifices, malheureusement détruits il y a un siècle, lors des fouilles : une chapelle d'Apis (d'où l'Apis célèbre du Louvre) (1) ; et le « *Lychnaption* » officine de la con-

(1) M. J.-Ph. Lauer vient d'en retrouver un petit modèle réduit, en schiste très intéressant, dont le dos est orné de représentations de la déesse Vautour.

frérie sacrée qui réglait les éclairages pour le culte de Sarapis, éclairages prophylactiques et d'effet plus ou moins magique. Nous avons, sur un carreau conservé du mur, le nom, malheureusement incomplet, du dédicant grec qui avait offert l'édifice du Lychnaption au dieu gréco-égyptien, en merci d'une cure miraculeuse analogue à celle dont bénéficia Démétrios de Phalère. Les statues ont été — sauf le Cerbère et quelques pièces plus maniables — découvertes sur le muret Sud dit « mastaba » - sud du *Dromos*. Elles seront réunies et préservées de ce même côté, non loin de celles de l'Exèdre. Elles avaient été signées aussi du nom d'un artiste grec, retrouvé incomplètement. Il y a encore quelques litiges sur le placement, car il ne peut s'agir, semble-t-il, d'un effet comparable à celui des « allées de sphinx »; la troupe est plus variée. Cinq fois, les animaux réels ou imaginaires qui apparaissaient sur la crète de l'enceinte du *Dromos*, sont représentés chevauchés : ainsi la panthère femelle (pl. V, 1), un lion, le cerbère égyptisant (pl. V, 2), et deux paons éployés faisant la roue (voir l'un d'eux pl. V, 1).

Il y avait, en plusieurs cas, des *paires* constituées de monstres ou d'animaux sacrés : p. ex. les deux paons, mais aussi les sphinx — un puissant dieu d'Egypte se mêlait peut-être à la troupe, la dominant : Sokar, faucon sacré coiffé du *pschent*, dieu des morts de Memphis, gardien de la Nécropole.

Toutes les statues animales sont traitées comme celles de l'Hémicycle ; elles sont du même temps et témoignent du même art.

Avec ce lot, nous sommes à nouveau en plein syncrétisme égypto-grec (cf. le Sokar, le Cerbère à trois têtes : lion, loup, chien, adapté par Bryaxis) ; mais aussi en pleine « liturgie » *bachique*, ce que montrent les pampres et les raisins partout répandus sous les pas des animaux sacrés ; et surtout la fontaine magique, représentée sous le groupe du lion chevauché par un « Bacchos ». Il faut penser à une fontaine de vin, et à une allusion au miracle du vin, produit par Dionysos *(Hymne*, 34). Cette thaumaturgie populaire était mise en œuvre, complaisamment, lors des grandes processions d'Alexandrie, comme celle, contemporaine de Ptolémée II, que nous a décrite Callixène de Rhodes (texte conservé par Athénée). On promenait alors en ville, sur des chars, des fontaines laissant coûler en permanence lait et vin. On peut désormais connaître l'origine de cette mise en scène :

dès le début des temps ptolémaïques, à Memphis. Et le rapprochement s'impose avec les documents de la toreutique, de la glyptique alexandrine, où nous voyons, parmi les mêmes figurations, les jeux rituels d'un *Dionysos Parapaizôn*, sur les limites de l'enfance, entouré de la troupe de ses *Bacchoi*, tantôt ailés, tantôt aptères, comme lui. Ils prophétisaient à l'occasion pour lui et en son nom, au Serapeum même de Memphis, semble-t-il, pendant l'ère lagide. Non seulement, les rapports avec les vases métalliques précieux de Boscoreale, de Pompei, de Berthouville, d'Hildesheim, etc. sont instructifs; mais il y a des comparaisons à faire avec les mosaïques d'Afrique, où le culte dionysiaque du paon avait prévalu en terre punique. La religion de Dionysos est en effet passée, comme on sait, d'Alexandrie à Carthage, ainsi qu'en Campanie, en Provence, en Ibérie, jusqu'aux « Colonnes d'Hercule ».



Chaque œuvre d'art, en tout temps, en tout pays, est un monument de civilisation, histoire, art, culte.

Le syncrétisme qui s'est produit à Memphis et s'est manifesté ensuite à Alexandrie, a eu les conséquences religieuses les plus étendues.

Le prestige de Dionysos — dieu macédonien du Pangée — a pris, au contact d'Osiris, d'Osor-Apis, un regain de force qui l'a rendu « méditerranéen », et a fait du dieu-enfant régénéré le rival le plus dangereux du dieu du christianisme, contre lequel il a mené le combat jusqu'à la fin de l'ère païenne.

Nous mesurons aussi la portée des réformes provoquées par Ptolémée Ier et ses habiles conseillers cultuels. La religion dionysiaque est revenue en Grèce propre avec de nouveaux aspects, propagés par la politique des Lagides (ainsi à Thessalonique, où, dans le Sarapieion local, on a trouvé une statue en marbre d'Harpocrate adolescent, entouré de pampres comme les animaux sacrés du *Dromos* memphite). En Egypte même, ainsi qu'en témoigne le Papyrus Gourob, entre autres, la religion dionysiaque s'est rajeunie et renforcée. On la retrouve plus puissante, du côté de l'Occident romain et punique, où s'est créé le culte d'un Liber Pater (cf. l'*Hymne* d'Ion de Chios, pour ce Dionysos « Pater » qui, au témoignage de Cicéron, était un dieu-enfant).

Du côté de l'Orient, le Dionysos memphito-alexandrin est passé en Syrie, en Nabatène, en Arabie (lions chevauchés de Timna); il a été diffusé aussi aux extrêmes limites d'un monde cosmopolite, car nous retrouvons sa trace sur le Tigre et l'Euphrate, et à Suse aussi, comme à Kapici-(« Begram ») et aux Indes, partout, en somme, à travers l'Asie.

Si l'on veut marquer utilement la place historique qu'occupent les statues dégagées du Serapeum — Hémicycle, groupes de Dionysos-enfant et des animaux — il suffit de noter que cette vingtaine d'œuvres, maintenant étudiées, a joué un double rôle déterminant.

C'est à Memphis qu'a été mis en valeur — dans un ensemble monumental, le premier en date et le seul qui nous soit conservé — le prestige de la vie littéraire antique, du travail spirituel des grands hommes de l'humanité, de ceux de la création poétique et de l'invention scientifique. L'Exèdre memphite des Poètes et des Sages a décidé de la vogue devenue traditionnelle des maîtres de la pensée, pour lesquels Alexandrie organisa des fêtes officielle (p. ex. l'*Apothéose d'Homère* du bas-relief d'Archélaos de Priène, au British Museum), et dont on grava si volontiers les images sur les *skyphoi* d'argent, produits de la toreutique du Delta (p. ex. représentation des maîtres de la Pléiade sur les gobelets de Berthouville ; de Démétrios de Phalère et d'autres philosophes ou poètes sur les *modioli* dits des « squelettes » (Boscoreale) ; ensuite, vase de bronze d'Hersthal, mus. de Bruxelles). Rien qu'un tel succès suffirait à la gloire des monuments du Serapeum.

Mais c'est l'Egypte de Memphis et d'Alexandrie, aussi, qui désormais nous apparaît comme le creuset où s'est reformée une puissante religion antique, venue à son heure ; elle avait su étendre déjà sa protection et sa compassion aux faibles ; une religion dont le dieu était un Enfant, un « Divine-Child » parmi les animaux inoffensifs ou redoutés (du paon au lion, au Cerbère !).

Pour la première fois dans le monde antique (où pourtant, les Enfances des dieux n'étaient pas oubliées, ni en Egypte, ni en Asie, ni dans le monde méditerranéen), on a vu une religion manifester au grand jour des tendances secourables, et développer aussi l'espoir de la survie. Outre les miracles de guérison qui

se faisaient par l'entremise de Sarapis, au Serapeum même [1], il faut relever l'organisation d'une culte de « Bacchoi », enfants, mediums consacrés qui distribuaient des oracles au nom de leur dieu, adolescent lui-même. Ce n'est pas pour rien que les épisodes culminants de la lutte finale entre le christianisme et le paganisme sont venus un jour se situer tragiquement autour du Serapeum d'Alexandrie, dérivé de celui de Memphis.

(1) Inscription du *Lychnaption*.

PL. I



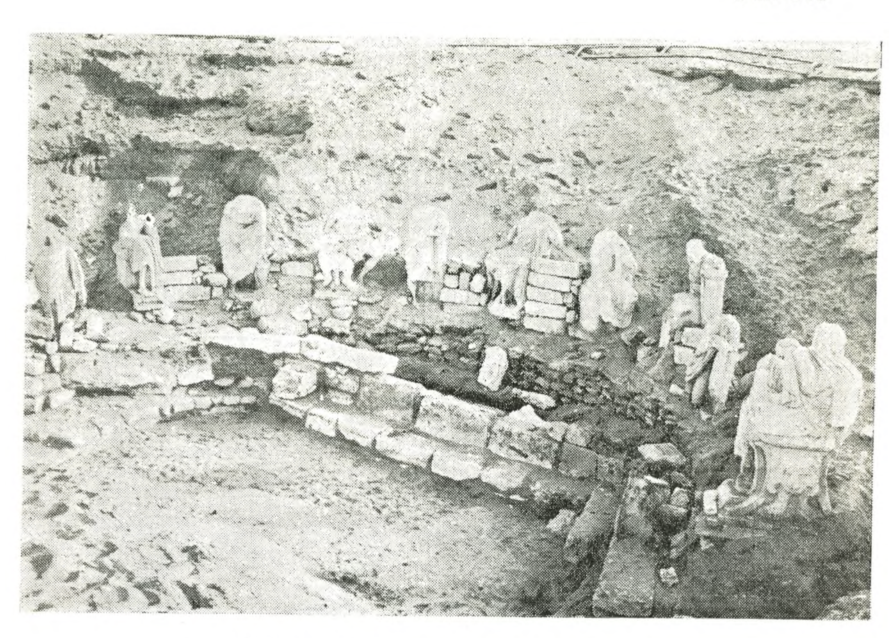
**Petits bronzes de Sarapis et du Cerbère tricéphale.
(Musée du Caire)**

PL. II



Démétrios de Phalère accoudé sur un hermès de Sarapis.

PL. III



1. — L'hémicycle des poètes et philosophes grecs.



2. — La mosaïque d'Umbra Sarsina. (Villa Albani).

PL. IV

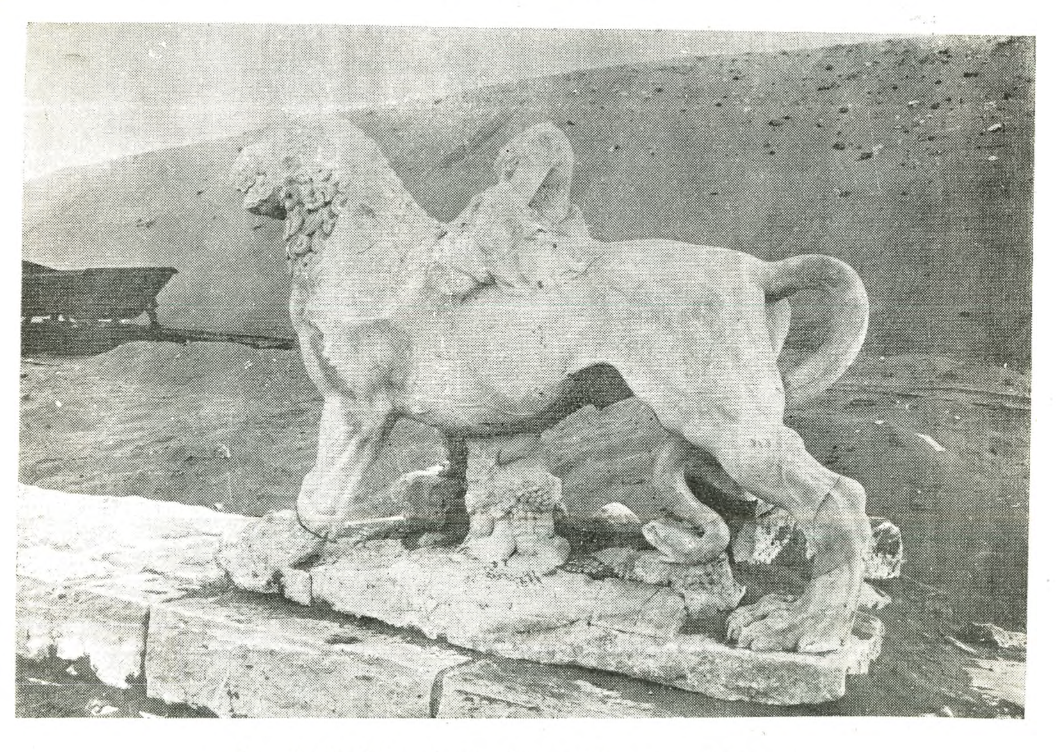


La statue de Pindare montrant son siège de métal.

PL. V



1. — La panthère chevauchée par Dionysos et l'un des paons faisant la roue.



2. — Le Cerbière chevauché par Dionysos adolescent.

PRINCIPES APPLIQUES AUX RESTAURATIONS DES MONUMENTS DE ZOSER A SAKKARAH [1]

par

JEAN-PHILIPPE LAUER

L'importance archéologique de Saqqarah ayant été révélée, il y a un siècle, par les sensationnelles découvertes de Mariette, l'excursion à ce site se limita longtemps à la visite du Sérapéum et du mastaba de Ti, à laquelle on ajoutait parfois celle des mastabas de Ptah-hotep et de Mererouka ou Méra. Ce n'est que depuis une vingtaine d'années que le principal centre d'intérêt s'est reporté sur la Pyramide à degrés et son magnifique complexe monumental construits pour la « demeure d'éternité » du roi Zoser, Horus Neteri-khet, par son célèbre ministre-architecte Imhotep, plus tard divinisé, que les Grecs dans leurs efforts de syncrétisme assimilèrent à Asklépios, en raison de ses talents médicaux.

Cet ensemble avait été dégagé de 1924 à 1928 par notre regretté collègue du Service des Antiquités, Cecil M. Firth, prématurément disparu en 1931. Appelé nous-même en fin de 1926 pour le seconder et étudier, du point de vue architectural, les curieux vestiges qu'il était en train de mettre au jour, nous sommes parvenu peu à peu à retrouver les formes et les proportions de ces édifices d'un style entièrement nouveau et inconnu jusque là en Egypte.

C'est ainsi que, depuis 1927, nous avions publié régulièrement après chaque campagne de travaux les résultats de nos recherches avec les dessins des restitutions que nous avions pu établir [2]. Dès 1936, nous étions en mesure de faire paraître

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(1) Communication présentée en séance du lundi 6 février 1956.

(2) Cf. J. P. Lauer, *Etude sur quelques monuments de la IIIème dynastie*, dans *Ann. Serv. Antiq. Egypte*, t. XXVII à XXXII, et *ibidem* t. XXX, XXXI, XXXIII, XXXVII à XXXIX, XLVIII: *Rapport sur les restaurations effectuées dans les monuments de Zoser à Saqqarah.*

deux volumes in -4°, l'un de texte et l'autre de planches, où, exposant les données et les méthodes qui permirent l'établissement de nos reconstitutions théoriques, nous présentions, avec une remise au point de nos premiers dessins et relevés, des restitutions nouvelles et des perspectives d'ensemble (voir par exemple pl. VI, 1) (3).

Ces diverses restitutions avaient pu être obtenues, en particulier, grâce au fait que les ouvriers, qui exploitèrent dès la période Ramesside ces monuments comme carrières, n'étaient heureusement pas parvenus à tout raser et avaient abandonné le plus souvent les assises inférieures déjà bien ensablées. En outre, ces carriers improvisés, recherchant avant tout des blocs simplement équarris, avaient généralement délaissé ceux qui présentaient des moulures ou des formes particulières, tels que les tambours de colonnes, les chapiteaux, les éléments de corniches ou de couronnements, etc... Ce sont ces précieux vestiges ainsi providentiellement épargnés et conservés dans le sable, dont il s'agissait de tirer le meilleur parti. Fallait-il, après en avoir déduit nos restitutions graphiques, les enfouir à nouveau ou les laisser en évidence sur le sol à proximité des monuments, ou bien les emmagasiner, ou enfin tenter de les réintégrer aux édifices auxquels ils avaient appartenu ?

En réalité ces questions, qui se posaient à nous ici, se sont posées également en de nombreux autres sites archéologiques dans bien des pays. Elles constituent un problème d'ordre général qui a vivement préoccupé les directions ou services chargés dans les différentes nations de la préservation et de la restauration des ruines antiques. Au cours des dernières décades, les thèses proposées ou les solutions adoptées ici et là ont été confrontées en divers congrès internationaux dont l'un des plus importants fut tenu à Athènes en 1931, à la suite des remarquables travaux exécutés à l'Acropole et au Parthénon sous la direction de l'architecte Balanos (4). C'est là, en particulier, que

(3) Cf. J. P. Lauer, *La Pyramide à degrés. L'architecture*, t. I et II (1936), *Compléments*, t. III (1939), ainsi que dans *Ann. Serv. Antiq. Egypte*, cahier n° 9, *Etudes complémentaires sur les Monuments du roi Zozer à Saqqarah...* (1948).

(4) Cf. en particulier les volumes 19 et 20 de *Mouseion* (organe de l'Office international des Musées) qui furent consacrés aux communications faites à ce congrès. Cf. également *La conservation des Monuments d'Art et d'Histoire*,

furent définis les principes de l'*anastylose*, entendant par ce terme « la réédification des colonnes avec leurs éléments d'origine dûment identifiés ». Ce congrès permit, en outre, de mettre en lumière quatre points particulièrement importants concernant la conservation et la réédification des ruines, à savoir que :

1°) Les éléments architectoniques, épars sur le chantier, sont beaucoup plus sujets à une dégradation rapide que ceux qui sont incorporés à une construction. Tous leurs côtés sont exposés aux intempéries, alors que les blocs constituant un édifice se protègent les uns les autres, ne laissant à découvert le plus généralement qu'une seule de leurs faces.

2°) Plus une ruine est importante et comporte d'assises, plus elle sera en mesure de résister aux forces destructives qui s'attaquent à elle et la rongent petit à petit.

3°) Le replacement effectif, dans l'édifice, de ses divers éléments architectoniques constitue une précieuse vérification des restitutions graphiques, toujours un peu théoriques, et peut ainsi permettre d'y apporter, le cas échéant, d'utiles corrections.

4°) La rédification, à condition d'être effectuée avec des soins scrupuleux, permet de retrouver des formes, de rétablir des proportions, et ainsi de recréer véritablement une œuvre architecturale autrement perdue ou défigurée.

Telles furent donc les considérations sur lesquelles nous nous étions fondé pour entreprendre dans les monuments de Zoser l'œuvre de longue haleine que nous poursuivons encore à l'heure actuelle.

Dès 1928, nos recherches effectuées principalement sur les tambours ou secteurs de tambours de colonnes, nous avaient démontré qu'un grand nombre de ceux-ci pouvaient être attribués avec certitude à telle ou telle colonne. Il y avait donc un intérêt évident à tenter dans bien des cas l'*anastylose ;* celle-ci se compliquait cependant du fait que, ici toutes les colonnes étant engagées dans des murs, il était indispensable de remonter également ces murs, au moins en partie. Or, si nous avions une forte proportion des secteurs de tambours, les blocs de parement simplement équarris nous faisaient, au contraire, pour les raisons déjà exposées, presque tous défaut, ce qui limitait évidemment

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nos possibilités. Comment donc pallier à ce manque de blocs équarris ?

Dans un premier cas, celui des colonnes autrefois portantes, qui, formant têtes de murs, dissimulent, vues de face, ces derniers, nous avions décidé de reconstituer tout ou partie de leurs piles d'appui, comme pour leurs tambours manquants, en briques ou moellons recouverts d'un fort enduit de pierre artificielle facile à teinter dans le ton voulu. Tel fut le cas des colonnes fasciculées de l'entrée (pl. I) et des trois colonnes cannelées du petit temple T de nos plans (pl. II).

Outre ces colonnes portantes, le complexe funéraire de Zoser présentait des colonnes purement décoratives ou symboliques engagées dans des façades. Dans ce second cas, le manque de pierres anciennes de parement à remployer est beaucoup plus grave, car la recomposition de la façade doit obligatoirement être conduite parallèlement à l'*anastylose* ; l'une ne saurait se concevoir sans l'autre. Force nous a été alors de limiter notre programme, en nous contentant pour les façades de vastes dimensions, comme celles des « Maisons du Sud et du Nord », qu'il était peu indiqué de reconstituer en enduit de pierre artificielle, de replacer les tambours ne nécessitant pas ou très peu d'éléments neufs de raccord, et de remonter avec les quelques pierres anciennes, dont nous pouvions disposer, le niveau supérieur de ces façades simplement jusqu'à la hauteur nouvellement atteinte par leurs colonnes (pl. III).

Nous n'avons envisagé l'anastylose complète de colonnes décoratives que dans certains cas de façades à surface beaucoup plus réduite, comme la façade aux petites colonnes-papyrus, qui a pu être reconstituée avec des pierres anciennes (pl. IV), et celle d'une chapelle à colonnes cannelées de la cour du Heb-Sed, dont nous entreprenons actuellement la recomposition.

L'heureux effet obtenu, en particulier, par l'anastylose de la petite façade aux colonnes-papyrus devait nous inciter à tenter la recomposition d'autres parois caractéristiques de l'architecture de Zoser, comme les murs à redans de la cour Sud et de l'enceinte, dont un nombre relativement grand de blocs gisaient au sol ; et cela, d'autant plus que des restaurations de recomposition analogues, effectuées en divers sites archéologiques d'Italie, de Grèce, d'Afrique du Nord, de Cyrénaïque, etc..., avaient bénéficié d'une approbation quasi unanime au Congrès International d'Athènes, dont il a déjà été question.

Si, en effet, le but essentiel de la restauration est de conserver les monuments, ce qui nécessite des travaux d'entretien, de consolidation et de protection, qu'il faut s'efforcer de rendre le moins apparents possible, il n'en est pas moins souhaitable, lorsqu'on dispose des éléments anciens voulus, et que l'identification et la position de ces derniers ont pu être préalablement déterminées avec certitude par une étude minutieuse, d'entreprendre des travaux de recomposition ou de réintégration. Ceux-ci, à la condition de ne pas s'appuyer sur des hypothèses incertaines, et de ne pas altérer les vestiges subsistant, peuvent être particulièrement heureux s'ils permettent de retrouver, ne serait-ce même qu'en partie, le caractère initial d'un édifice, ou de remettre en valeur certains de ses éléments importants.

Tel fut précisément le cas pour la recomposition de ces murs à redans de la grande cour Sud (pl. V) et de l'entrée de l'enceinte (pl. VI, 2), dont nous avions auparavant réussi à identifier et à déterminer de façon tout à fait sûre la position des éléments de leur partie supérieure recueillie dans le sable. Dans la cour Sud, par exemple les pierres ornées de cobras à la tête dressée appartenaient indubitablement au couronnement de l'avant-corps formé par le sanctuaire du tombeau de l'enceinte Sud ; partout ailleurs autour de la cour le mur de parement était orné de redans semblablement constitués, mais sans frise de cobras à la crête.

En ce qui concerne, d'autre part, l'étude préliminaire du mur d'enceinte bastionné(pl. VI, 1 et 2), les nombreux éléments ornés de petits rectangles [5] qui gîsaient encore au pied, nous avaient été particulièrement précieux. Des superpositions de ces éléments étant apparu possibles, nous avions alors fait de nombreux essais dont plusieurs s'avérèrent des réussites. Ce sont ces dernières qui nous ont permis de retrouver l'ordonnance des assises et de savoir que ces rectangles étaient disposés, horizontalement suivant huit rangées parallèles, régulièrement espacées de 45 à 47 cm., et verticalement dans l'axe de chacun des panneaux rentrant ou saillant qui constituent les redans. Les deux

(5) Ceux-ci visibles sur notre pl. VI, 2 simulaient les extrémités de poutres de chaînage que l'on disposait dans la partie supérieure des grands murs de brique crue pour renforcer leur cohésion.

rangées supérieures étaient disposées dans la partie exempte de redans correspondant au parapet du chemin de ronde (6). Quant aux blocs du couronnement même du parapet qui formait en même temps le couronnement de la façade de l'enceinte, ils présentent un arrondi en quart de cercle vers le chemin de ronde. La plupart de ceux dont nous pouvions disposer ont repris place au sommet de la façade reconstituée de l'entrée de l'enceinte, où il nous reste à les raccorder par un fort enduit de pierre agglomérée aux éléments du dallage du chemin de ronde que nous venons de replacer.

Telles sont les principales restaurations de recomposition qui ont été effectuées ou sont actuellement en cours dans les Monuments de Zoser. Peu à peu ressuscitent ainsi à nos yeux les formes et les proportions de ces constructions préhistoriques qu'un architecte génial sut aux premières heures de l'histoire transposer et réaliser dans la pierre avec une maîtrise sans précédent, qui force aujourd'hui encore notre admiration.

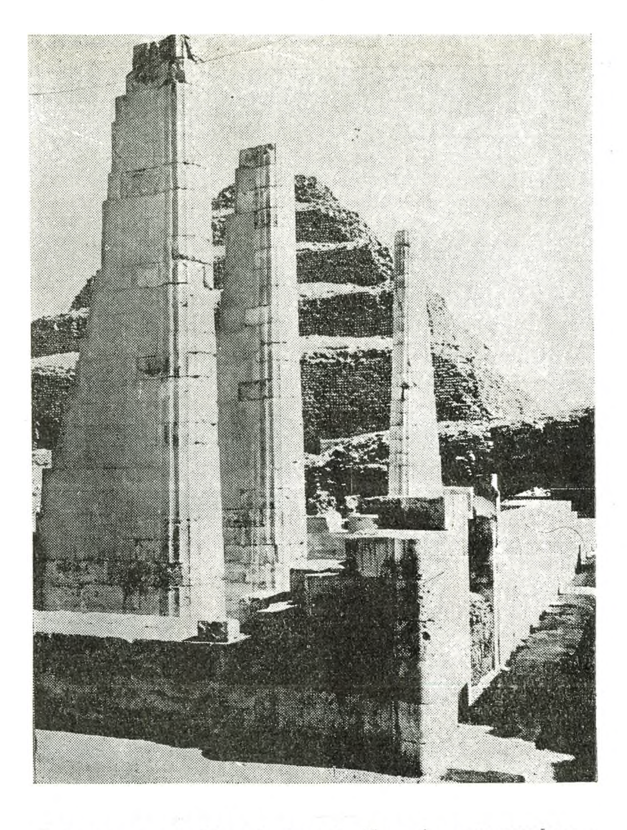
(6) Cf. J. P. Lauer, dans *Ann. Serv. Antiqu. Egypte.* t. XLVIII, *Restaurations et «anastylose» dans les monuments du roi Zoser à Saqqarah*, p. 356 à 363, et surtout p. 356-357 et fig. 1 à 3.

PL. I



Colonnes fasciculées après « anastylose ».

PL. II



Colonnes cannelées du temple T après « anastylose ».

PL. III



1. — La « maison du Nord », lors de la découverte.



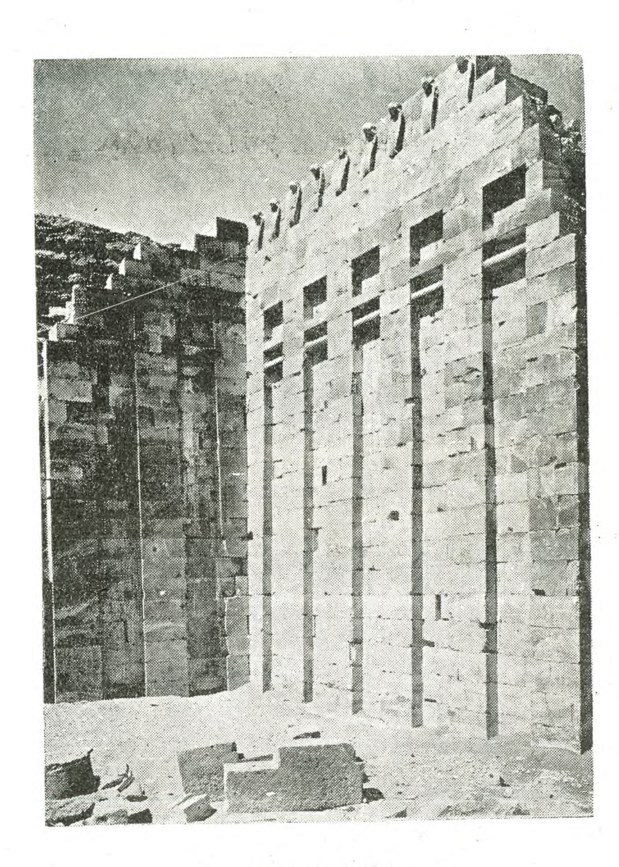
2. — La même, après restauration.

PL. IV



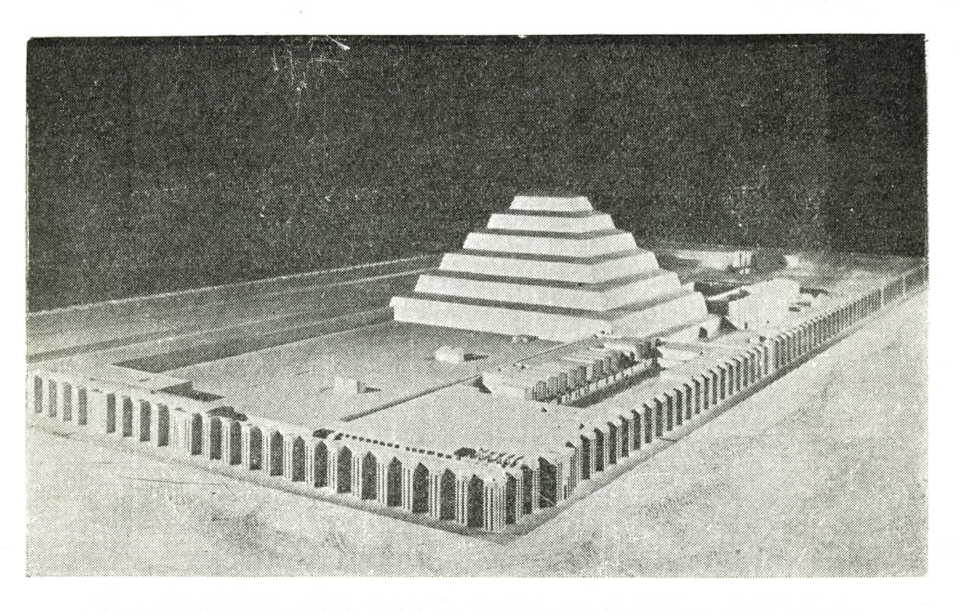
Les colonnes-papyrus après « anastylose ».

PL. V

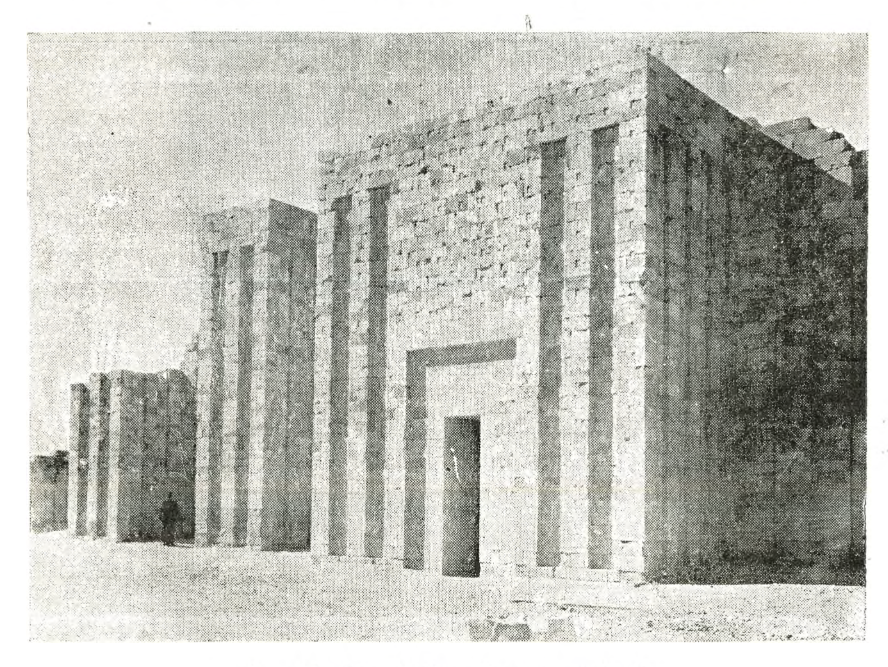


Le mur « aux cobras ».

PL. VI



1. — Reconstitution d'ensemble des monuments du roi Zoser (maquette).



2. — L'entrée de l'enceinte reconstituée.

REMARKS ON THE URANIUM CONTENT OF ROCKS OF ASWAN DISTRICT (1)

by

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ABSTRACT

Samples of the different rocks in the neighbourhood of Aswan District were analysed for their U content. It varies from < 1 to 16 ppm. with an average of 5.5 ppm. The aplites and pegmatites have relatively higher U content than the granites.

INTRODUCTION

The writers handed rocks representing most of the different types exposed in Aswan District to Dr. Younis S. Selim of the Physics Department of Alexandria University for the estimation of their uranium content. Dr. Younis (personal communication) used methods of determination discussed in detail by Yagoda (1949).

RESULTS

The analysed rocks are granite, aplogranite, aplite and pegmatite ; schist and hornfels ; and basalt and camptonite. Their petrographical characters, chemical composition and mode of origin will be given, in detail, in a forthcoming publication by the writers. The uranium contents of the different studied rocks are listed in Table (1) which also includes their geographical location. However, reference should be made to Ball's map (1907) or to that of Little and Attia (1943) for their exact positions.

DISCUSSIONS

It should be mentioned that the number of the analysed samples is not frequent enough for drawing any definite conclu-

(1) Communication présentée en séance du 5 décembre 1955.

sions. However, it can be seen that the aplites and pegmatites are, in general, richer in U than the coarse- and fine-grained granites. The U contents in the analysed aplite and pegmatite are as high as 10 and 7 ppm. respectively, whereas, the highest content in the analysed coarse- and fine-grained granites are only 4 ppm. The analysed aplogranite is markedly richer in this element than the granites. It has 16 ppm. compared to the maximum content of 4 ppm. in the other granitic rocks and, therefore, it is more related to the aplites and pegmatites. The average content of the analysed granites is 2.5 ppm. which is lower than that given by Senftle and Keevil (1947) for granitic rocks (3.963 ppm.). The relative richness of microcline in U is indicated by (a) the exceedingly high content (131 ppm.) in the microcline porphyroblast in the fine grained granite (No. 2 in Table 1), (b) the appreciable amount of this element (5 ppm.) in the analysed microcline porphyroblast in the coarse-grained granite (No. 7, Table 1), and (c) relatively high content of the microcline pegmatite (7 ppm.) and of the microcline-rich aplogranite (16 ppm). This confirms Page's view (1950), that microcline pegmatites are relatively rich in U.

It is significant to find that the dark hornfelsic and schistose rocks contain detectable amounts of U varying between < 1 and 6 ppm. This fact adds strength to the view that the metasomatic development of the granitic rocks would not necessarily need addition of material from extraneous sources since the country rocks contain the elements required for the composition of the granite, including the exceedingly rare element U.

The analysed basic dyke and camptonite possess remarkably higher contents of U (12 and 14 ppm. respectively) than those given by Evans and Goodman (1941) for basalts and diabases (0.83 ppm.).

On the whole the U content of the analysed crystalline rocks of Aswan, excluding the exceedingly rich sample of microcline porphypoblast (No. 2), differs from < 1 to 16 ppm. with an average of 5.5 ppm. This is not appreciably higher than Hevesy's average for igneous rocks (4 ppm.) recorded by Rankama and Sahama (1949, p. 632) but remarkably lower than that of Egyptian Upper Cretaceous phosphatic deposits at Koseir (average 34 ppm.) and at Sebaiya (average 66 ppm.) studied by Abdel-Mohsen (1954).

TABLE 1.

Uranium Contents of Rocks of Aswan District.

Serial No.	Type of rock	U in ppm.
1	Microcline pegmatite	7
2	Microcline porphyroblast in fine-grained granite	131
3	Aplite	10
4	Aplite	*
5	Coarse-grained pegmatitic granite	2
6	Coarse-grained granite	*
7	Microcline porphyroblast in coarse-grained granite	5
8	Coarse-grained granite	1
9	Medium-grained granite	4
10	Aplogranite (microcline-rich)	16
11	Fine-grained granite	2
12	Fine-grained granite	*
13	Fine-grained granite	*
14	Biotite-gneiss	5
15	Dark relics in microcline porphyroblast No. 2	10
16	Dark skialith in granite No. 13	4
17	Dark schistose skialith	3
18	Dark hornfelsic skialith	6
19	Dark hornfelsic skialith	*
20	Basic dyke	12
21	Camptonite	14

* U if present is in amounts considerably less than 1 ppm.

Numbers of rocks in brackets correspond to those numbers of Aswan collection of samples in the Geology Department, Alexandria University.

1 = Microcline pegmatite (No. 74) from ancient cutting south of Aswan town.

2 = Microcline porphyroblast in fine-grained granite (No. 39 B) from old golf course.

3 = Aplite (No. 31) in coarse-grained granite near Mahata village.

4 = Aplite (No. 47) from old golf course.

5 = Coarse-grained pegmatitic granite (No. 106) from northeast of Gatania.

6 = Coarse-grained granite (No. 60) from Gebel Ibrahim Pasha south of quarry.

7 = Microcline porphyroblast in coarse-grained granite (No. 58A) from Gebel Ibrahim Pasha south of quarry.
8 = Coarse-grained granite (No. 58B) same as 7.
9 = Medium-grained granite (No. 14) from near the English Cemetery, Aswan Dam Road.
10 = Fine-grained aplogranite (No. 32) from near Mahatta village.
11 = Fine-grained granite (No. 54) from Gebel Ibrahim Pasha south of quarry.
12 = Fine-grained granite (No. 46) from old golf course.
13 = Fine-grained granite (No. 39A) from old golf course.
14 = Biotite-gneiss (No. 26) from southern end of Gebel Bas.
15 = Dark relics in microcline porphyroblast in fine-grained granite (No. 39B) from old golf course.
16 = Dark skialith in granite (No. 39A) from old golf course.
17 = Dark schistose skialith (No. 21) from Gebel Tegog.
18 = Dark hornfelsic skialith (No. 55A) from Gebel Ibrahim Pasha south of quarry.
19 = Dark hornfelsic skialith (No. 35) from near quarry at the eastern side of Aswan Dam Road.
20 = Basic dyke (porphyritic basalt No. 42) from old golf course.
21 = Camptonite dyke (No. 37) east of quarry at the eastern side of Aswan Dam Road.

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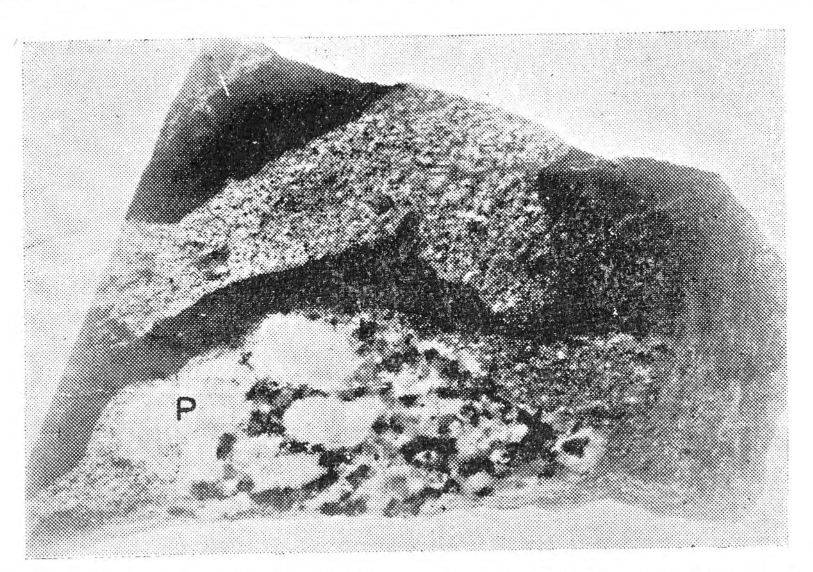


Fig. 1. — Coarse-grained granite from Gebel Ibrahim Pasha south of quarry, Aswan Dam Road (No. 8 in Table 1). The porphyroblast "P" (No. 7 in Table 1) is shown. The sample countains also fine-grained granite and dark skialith. Half natural size

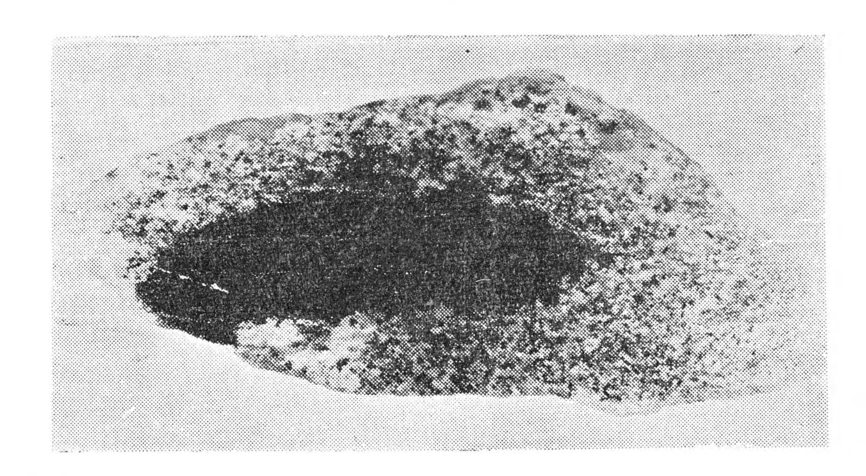


Fig. 2. — Dark skialith (No. 16 in Table 1) in fine-grained granite from old golf course (No: 13 in Table 1). The other side of this sample contains the microcline porphyroblast (No. 2 in Table 1). Half natural size.

EXPANSION OF THE ARABS: ITS RELATION TO CLIMATIC CHANGES AND OTHER FACTORS

by

S. HUZAYYIN

Introductory:

The expansion of the Arabs which started from Arabia in the 7th century A.D. represents one of the major phenomena in human history. It carried Arab culture and Islam far wide to the west and the east both by land and by sea. This great movement, however, did not represent an isolated phenomenon. It came as a link in a chain of movements of expansion from the Semitic steppe-lands of the Near East. The history of those earlier Semitic movements of expansion is a complicated one; and it is not proposed to deal with them here in any detail. Suffice it to say that views have widely differed upon the original cause of those early expansions and migrations from the desert and the steppe. Some authors would attribute them to what was coined by E. Huntington as the pulse of climate — namely fluctuations and oscillations in the amount of precipitation over the great Asiatic belt of steppe-lands and its borders. Others would simply attribute these migrations to purely political reasons — namely the decline in the power of empires adjoining the steppe-lands and the consequent inducement to the hordes of nomads to migrate to the settled plains. Rare among researchers are those who tried the possible combination of the two sets of factors. It is our intention in this short paper to survey the possibilities of those natural and human factors which may have directly or indirectly affected the expansion of the Arabs from their peninsula.

Archaeological Evidences of Climatic Changes:

The school of changeability of climate in south west Asia in historical times was first championed by E. Huntington. His early researches pertained to Palestine in Biblical and earlier times, and he came to the conclusion that the Palestine of those days was favoured with better rainfall and vegetation than in

later times. Its past climate was marked with fluctuations which forced the bedouins to migrate and seek shelter and abode in the near-by plains of Egypt or in the settled oases of Syria as well as in the borders of Iraq.

The gist of the views of E. Huntington, C.E.P. Brooks and others is that a so-called period of classical rainfall existed and extended (with oscillation) roughly from 1800 B.C. to A.D. 500, though it was best represented from 1200 B.C. to A.D. 200. Other historians such as Caetani have tried to apply similar views to Arabia of early Islamic days, though in their enthusiasm they put forward evidences which were not always convincing. Caetani, for example, thinks that the fact that parts of Arabia were in former times more forested than at present, and that several of its wild beasts have now become extinct may be taken as an indication of increasing dryness of climate. In a country like Arabia, however, where woodlands are naturally restricted and where people depend on wood for fuel and other purposes, deforestation is better regarded as the result of the action of man. The extinction of wild animals in such a desert country may be explained on the ground that those animals are easily trapped at the watering-places, where they are obliged to call. This is perhaps the reason why it is that, on the steppe and semi-desert, the domestication of tamable animals and the extinction of comparatively more fierce ones is achieved at an earlier date than in more prosperous lands.

But the problem of changeability of climate and the onset of dryness which led to outbursts of tribes from semi-desert and desert areas should be approached from a different angle. Evidences of former changes and onset of desiccation should be looked for in more than one field. Archaeology is perhaps one of the main sources for reliable evidence, at least of the change which took place since Roman and early Christian times. The coast of Mariut district to the west of the Nile delta is covered with a series of large cisterns which belong to the Graeco-Roman phase. These cisterns are now dry, and most of them filled with sand. But even if they were cleaned up, it is estimated, with good reason, that they would never all get filled up with the winter rain which now falls in the district. The large temples whose remains are still standing are a clear indication that Mariut was a district rich in cultivation and vineyards. At present the great efforts to revive the area are much hampered by both the insufficiency and uncertainty of water-supply. If

we pass on to North Arabia we find similar archaeological evidence . The deserts of Transjordan and Syria have a multitude of Roman cisterns whose abundance and large capacity may be taken as a sign of greater precipitation of rainfall. It is true that these cisterns must have been built at different times when the older ones got filled with debris and sand ; and that consequently their evidence as indicating desiccation in later times may not be conclusive ; but they should not be taken alone into consideration. The large camps of Roman garrisons, the theatres and huge buildings attached to them, as well as the roads which covered the face of what is now desert must be taken as an indication of better climate than at present prevails. In addition to this must be added the existence of remains of large cities, with their temples and palaces, such as the famous Petra and other centres further north (Bostra, Palmyra, etc.) where the supply of local rainfall and underground water is at present utterly insufficient for their maintenance. In fact the study of the locations of these ancient cities and the trade routes serving them supports the evidence of desiccation and gives further indication that the onset of dryness was gradual and took place during the first few centuries of the Christian era. The crossing of the Syrian desert between the eastern and the western horns of the Fertile Crescent was gradually shifted from south to north. The head of the trade routes on the western side (dominated by the Romans and Byzantines) was first at Petra (capital of the Nabataeans north of Aqaba), and then shifted northwards to Bostra, Damascus and Palmyra in north Syria. This northward shift may have been partly due to the development of the ports of the coast of Phoenicia instead of Gaza in relation to the gradual rise of the Byzantine Empire and the advancement of north Syria and Mesopotamia as centres for religious and mercantile enterprise. But it is equally possible that a gradual onset of desiccation may have made the maintenance of the southerly routes and crossings impossible. We shall come back to this point when we discuss the rôle of the trade activity in its relation to Arab expansion.

Another interesting piece of evidence comes from the study of underground water-level in the Transjordan desert. There are clear indications from the Azraq depression that the underground water-level which supplies the springs has fallen by some 6 feet since Roman times. This could not be attributed to any increase in the digging of wells in that depression, as in fact it was more

populous in Roman times than at present. But perhaps the most important area from which we can draw archaeological evidence of dryness of climate is the south-west plateau of Yemen and Hadramaut. There, especially in Yemen, the climate was always and is still more humid than in any part of Arabia. The rainfall being more abundant, its oscillations were always more appreciable in amount, and thus more easily discerned. The plateau of Yemen with its extension towards Hadramaut, was the site of a series of ancient civilizations. This plateau may be roughly divided into three levels. (1) The so-called Minnaean Jauf (= interior) which lies in the north-east, in the rain-shadow of the higher toplands of Sanaa, at a level of less than 1200 metres (above sea-level) in general. This is now within the semi-desert zone. (2) The southern Jauf or the Maarib level which extends to the borders of Hadramaut at an altitude of 1200 to 1700 metres. It receives a slightly higher amount of rainfall, being somewhat higher and more situated to the south. (3) The toplands of Sanaa and the rest of the high mountains above 1700 metres (Sanaa itself at about 2300 m.). These toplands rejoice in both temperate conditions and heavier rainfall, reaching 50 cms. or even more. Archaeological evidence from south-west Arabia, mainly inscriptions, bring out three distinct and successive phases of civilization, each of which may be associated with one of the above-mentioned levels of altitude. These are the so-called Minnaean, Sabaeo-Himyarite and Ethiopian. It is difficult to give any definite dates for each of these phases, and particularly the first two which overlap. But on the whole, the earliest Minnaean inscriptions may be dated at about 800 B.C., if not a little earlier. The chief centre of power at that time was at Qarnawah in the northern Jauf. As from 550 B.C., however, the centre of power in Yemen became shifted upwards to the middle level round the city of Maarib the capital of the Sabaeans. Later on, about the year 115 B.C. another power appeared in South Arabia. These were the so-called Himyarites whose accession to the power in place of the Sabaeans was probably due to sheer political disturbances among the tribes. Maarib the higher capital continued to act as the chief city of the Himyarites whose culture and power extended eastwards in the direction of the valley of Hadramaut. Many cities rose up at that time, but it is interesting to note that they were all in the interior of South-West Arabia, and lay still in the rain-shadow area of the high plateau of Sanaa. Those cities represented oases which exploited the water of the streams descending from the high plateau, as well as the stretches of steppe-lands which were still rich with vegetation. Maarib itself had a famous dam, and its gardens were well described in the Koran. At present not even the restoration of the ancient dams would suffice to revive life in that remote interior of South-West Arabia. The southern Jauf acted as the seat of power for both Sabaeans and Himyarites because it must have received more rainfall and more run-off and drainage than it does at present. A change, however, in the seat of capital came with the arrival of the Ethiopians in Yemen about A.D. 525. The invaders must have found the Jauf of Yemen too dry to act as the seat of their capital; and the chief city of Yemen was built up at Sanaa on the higher level. It is interesting to note that this removal of the seat of power in Yemen coincided with the suggested date of final desiccation in northern Arabia — namely the end of the so-called period of classical rain-fall. It is also interesting to note that the toplands of Yemen above 2000 metres which were singularly poor in remains of cities or inscriptions from the Sabaean and Himyarite periods, became the seat of political power in the Yemen since the days when Sanaa was established. The power of Islamic Yemen was always established on those higher top-lands, or on the western and south-western sides of the plateau, which received higher rainfall, because they faced the winds which brought rain. Cities like Sanaa, Taiz, Ib, Manakha etc. all lay either in the topland area or on the windward side of the Yemen Plateau. Zabeed (another Islamic centre but on a much lower altitude) lay on the westward edge of the plateau, with more abundant run off brought down by torrents.

It is feasible, therefore, to conclude that from the study of the location of the main centres of power and cities on the Yemen Plateau, there must have occurred a gradual onset of dry condition, which led to the gradual climbing of the plateau into the direction of better-watered areas and levels. This conclusion is also supported by another piece of archaeological evidence which may be drawn from the study of the location of ancient cisterns as may be compared with modern ones. In areas where Sabaean or Himyaritic influences extended, large cisterns were built up usually on the surface of elevated spots. The cisterns were exceptionally large, but they must have been filled with water in those days. At present the rainfall is enough only to supply these cisterns with limited amounts of water, filling only their

bottom parts. The present population in such areas have been obliged to dig their cisterns and waterpools at a lower level, usually in the centre of a natural collecting basin. A striking example of this shift of the place of a cistern can be seen at the town of Nait in north east Yemen, which was a prosperous city with temples and high cisterns in Sabaean and Himyarite times, but has now become a decadent village with a low-lying and unhealthy water-pool at the apex of a collecting basin.

Historical Documents Indicating Changes of Climate:

But apart from such archaeological evidences which strongly point out to the change of climate towards aridity in both northern and southern Arabia, other evidences pointing into the same direction, may be drawn from sources of historical documents or legends. These documents may be drawn from both Graeco-Roman and Arab sources. In fact we do possess some literary evidences which are mainly derived from descriptions of various parts of Arabia, especially the south-west, by Greek writers, who have either visited or heard about the country in their times. Most of these descriptions relate to what is now Hadramaut. To these writers, this was the country of spices and incenses par-excellence. Strabo (A.D. 20) speaking of its people says (Strabo 16,4,19), "Amongst them myrrh, frankincense and cinnamon are produced, and on the sea-coast also balsam and other fragrant plants, though their perfume soon passes away." It is possible that some of these products may have been originally imported from Sokotra or Ethiopia, or even from India; but at any rate the country does not at present produce any of these plants. Moreover the valley of Hadramaut is described by Greek writers as being very unhealthy. The picture they drew of it approaches in a way what we see in semi-jungle valleys. This gave rise to an ancient legend, reflected in the name of the country itself which means death is present. In other words Hadramaut was considered in a way as the valley of death, while at present it is a healthy land. According to an early traveller's tale, appearing in Herodotus and other writers, the air of Hadramaut was very much scented with the overpowering fragrance of incense which spread death. Diodorus Siculus (2, 48-9) related that even the earth exuded a sweet fragrance when it was dug. Another picture is given by the author of the Periplus of the Erythraean Sea (A.D. 80): "The incense is collected by the king's slaves, or by malefactors condemned to this service as punishment. The country is unhealthy in the extreme, pestilential even to those who sail along the coast, and mortal to the wretched sufferers employed in collecting the frankincense who perish likewise as often by want and neglect as by the pernicious influence of the climate. The country inland is mountainous and difficult in access; the air is foggy, loaded with vapours caused by the noxious exhalations from the trees that bear the incense." We may well deduce from these descriptions, however legendary in nature some of them may be, that the bottom of the valley of Hadramaut and the coastal plains were by no means inviting for settlement, probably by reason of malaria and other diseases caused by stagnant waters. This is supported by the fact that the most important of the archaeological remains of the country come from the western and upper stretches of the valley. In this district lies the ancient capital of Shabwah, in the arid plateau area between Yemen and Hadramaut, unlike the modern towns of Shibam, Saioun and Tareem which lie in the middle and lower parts of the valley where subterranean waters still make garden irrigation possible. It may be safe to deduce that the dryness of climate which took place sometime during post Graeco-Roman times led to an amelioration in the hygienic conditions, especially in the middle and lower parts of the valley of Hadramaut. At the same time, however, the desiccation of climate gradually had a disastrous effect upon the incense production of the country. This happened at a time when demand for this commodity in the Roman world was steadily increasing, owing to the spread of Christianity and particularly after its recognition, in the fourth century A.D., as the official religion of the empire. The need for more incense was also felt in the Syrian and Nestorian churches, which were associated with monastic activity on the edge of the drying deserts of northern Arabia. The failure of the produce of Hadramaut and the southern coasts of Arabia, as well as Sokotra and Somaliland, to satisfy the growing needs of the north, seems to have induced the Arabs to expand by sea and look for supplementary amounts of incense and spices produced in other countries round the Arabian sea.

But Graeco-Roman sources are not alone in indicating possibilities of climatic changes. Arab sources, though written at a much later date, contain references to early and pre-Islamic conditions of better rainfall in some parts of Arabia. Legends about famous poets and knights speak of the facility with which

they could roam about Arabian deserts. Umru'ul-Qays, the legendary hero and poet of pre-Islamic times started most probably in the Ahqaf region north-west of Hadramaut and was able to reach the confines of Anatolia. The so-called Period of Ignorance in Arabia was also marked with wide tribal movements and migrations, which may safely be taken as an indication of unsettled climatic conditions. It is interesting to note that it has become proverbial amongst the Arabs that Yemen was the cradle-land of the Arabian tribes, and that Iraq with its well-irrigated plains became their graveyard. We know that the tribes of Azd, Qudaah and others had migrated from eastern Yemen across southern Najd to the Hasa area on the Arabian (Persian) Gulf, where they settled for a while before moving on to the borders of Iraq and Syria.

It is of course quite likely that the break of the famous dam of Maarib some time between 440 and 450 A.D. led to large-scale migrations from the vicinity of that ancient town ; but it is very likely that the migrations started at least a century or two earlier owing to the gradual onset of drier conditions. Such aridity would affect not only the area irrigated by the dam, but the whole of the interior of Yemen with its floral wealth. But even after the tribes which moved from south Arabia had settled on both sides of the fertile crescent bordering the Syrian desert, conditions seem to have continued to become increasingly drier than before. This was reflected in the intensification of warlike habits and hostilities among the tribes of Arabia for the commanding of pastures and watering places. Also among the customs which the Arabs of the Period of Ignorance (before the appearance of Islam) developed and which Islam prohibited, was the killing of girl-descendants. We understand from the Koran that this was not just done "for fear of shame," but rather for "fear of dearth." Conditions in pre-Islamic Arabia seem to have been gradually approaching a climatic crisis which took place early in the 6th century A.D. This is referred to in the legendary accounts preserved in the writings of some Arab historians of later times, such as Masudi (vol. I) of the 10th century A.D. Amongst these is the story of a "very old man" from Hirah (near the modern Karbalaa) who gives the following narrative in the year A.D. 632 : "During the early day of my life, any woman from among the people of Hira could traverse the country to Syria on her own... She passes by a string of settlements and a succession of streams and fruit-bearing trees, until she arrives at her destination quite safe. Look ! how everything has changed ! and how desert prevails everywhere !"

Other Environmental Factors Affecting the Expansion of Arabs.

From the above survey we may well see that the expansion of the Arabs both by land and by sea was affected by a climatic change which led to gradual aridity during the few centuries preceding the appearance of Islam ; the crisis reaching its climax some time about 500 A.D. The evidence, archaeological and otherwise, for the onset of this aridity is too strong to be overlooked. It would be misleading, however, to think that desiccation was the only factor affecting the movement of spread from Arabia, or that it was even the only natural factor which affected this movement. The geographical situation of the Arabian peninsula was in itself a particularly important factor. Arabia differed from a peninsula like that of India in the fact that it was a land of passage and not a terminal peninsula of Asia. Space-relationships between Arabia and both Africa on the one hand, and the rest of the Asiatic continent on the other, greatly facilitated the outward movement of the Arabs. The picture which is usually drawn of the Arab movement of expansion is that the bedouins of Arabia preferred to spread by land. A deeper insight into the history of Arab expansion, however, brings forward the important fact that the Arabs had spread by sea as much as they did by land. The Arabian elements of the Arabian (Persian) Gulf were in fact the ancestors of the Phoenicians — for it has now become evident that these latter may have risen on the shores of that gulf. The mariners of the southern coasts of Arabia and Hadramaut were well acquainted with navigation in the Arabian Sea and Indian Ocean at a particularly early date. It is rather interesting that mariners from the coasts of Oman spread mostly towards the Zandj (negro) coasts of Africa, while the people of Hadramaut (Phoenicians of the southern seas) spread eastwards as far as the south-east corner of Asia. In this way the people and cultures of the eastern and southern coasts of Arabia became deeply connected with maritime activity in the Indian Ocean. Thus we may well see that while the space-relationships of northern Arabia encouraged the spread by land, maritime conditions in the east and south encouraged expansion by sea. This was perhaps why Islam as a new religion had the opportunity of spreading into the three directions of east, west and south. The existence of the mountain chains of Anatolia in the north,

and the fact that they extended from east to west, represented a barrier which prevented the Arabs from freely expanding in a northerly direction. It is interesting to note that Armenia which lay to the extreme north of the chains maintained its Christian character to the present day. It is also significant to note that Islam was carried into the heart of Anatolia and beyond towards the Balkans not by the Arabs but by the Osmanli Turks who were converted to Islam and carried it during their spread westwards along the main line of the chains.

The geographical situation of Arabia also was an important natural factor which helped the movement of spread. It is interesting that Arabia was not an island surrounded or even a peninsula entirely skirted on one side by the waters of the sea. If the Mediterranean were linked either to the Red Sea or to the Arabian (Persian) Gulf, it would have been possible for the people of the west to join hands with those of the south and south east without passing over a land-bridge in Arabia. The existence of this land-bridge meant that no connection or intercourse between east and west could be established without the Arabs and their land taking part in it. It fell to the people of Arabia to play the part of intermediaries since times immemorial. This made them acquainted with their neighbours both in adjacent areas and in territories far away by land or by sea. When the time came for the Arabs to spread from their peninsula and take the new religion with them, their task was greatly facilitated by the existence of a long tradition of early contacts.

Another factor pertaining to the environment of Arabia and also affecting the movement of outburst and expansion is perhaps the appearance of the breed of the Arab horse. So far as is known there is no definite information as to the exact date of the introduction of this new and vigorous ally of the tribesman into the heart of Arabia. But it is almost certain that such an introduction could not have taken place at the same time as the animal was brought to the fertile plains of the Crescent and Egypt (where it came as an ally of the Hyksos about 1700 B.C.). The horse is essentially an animal of the rich pasture lands; and it must have taken a comparatively long time to breed the new "Arab" type, which could stand more severe conditions of draught. But in any case, it is almost certain that by the early centuries of the Christian era, the Arab breed had fully evolved. The fact that the famous civil war of "Dahis" and "Ghabraa" between two of the most powerful tribes of pre-Islamic Arabia,

and which is said to have lasted for 40 years, was called after the names of a horse and a mare, is no weak evidence that the horse must have played an important part in the disturbances of the "Period of Ignorance". It is true that the horse remained always as a luxury animal within Arabia, and that it never superseded the camel; but its existence provided the bedouin with a strong ally in his struggle to dominate the settled plains.

Non-Environmental Factors Affecting the Expansion of the Arabs:

We should not, however, limit our analysis of the factors affecting the expansion of the Arabs to the natural and environmental sphere. There can be no doubt that this great movement was also influenced by other factors which did not belong to their changing environment. These factors had a special effect upon the movement of outburst, though they did not always work in one or the same direction. Amongst these factors special emphasis must be laid upon the appearance of Islam. It is particularly significant that the outburst from Arabia, which followed upon the appearance of Islam differed drastically in its effects upon neighbouring civilizations from the earlier outbursts of the Semitic elements from Arabia, or still more from the devastating outbursts which took place at various times from the steppe-land of Inner Asia, since the days of the Huns down to those of the Tartars and Monguls. We know from history that whatever may have been the reasons for the outward movement which took place from the steppe into the sown (whether they were climatic pulsations or not), the result was nearly always the devastation of settled life on the conquered plains. The movement of the Arabs in early Islamic times had totally different results. It must be recognised that the new religion gave the bedouins a new message and a spiritual outlook which subdued their temptations and ferocity. They had something to offer to the lands and peoples around them. At the same time the conflict which they had to face during the initial stages of their expansion in the Near East was not a particularly severe one. We must remember that the appearance of Christianity, the religion based upon love, had prepared the ground for the acceptance of the new creed of Islam, based upon brotherhood. Actually the Christian elements in northern Arabia and in Egypt, for example, did not find it difficult to shift over from Christianity to Islam, which after all, had many things in common. At the same time the liberal attitude of Islam which preached

equality between "Arab" and "non-Arab" had the double effect of subduing and taming the tribesmen, and of inducing the non-Arab to join into the common life of Islam. We are therefore led to the conclusion that although environmental factors, such as the changing climate or the appearance of the Arab breed of the horse, might have led to a ferocious outburst from Arabia, the situation was entirely changed by the appearance of Islam. This new creed which gave the Arabs further enthusiasm and impulse to carry the message into the outer world, was at the same time a most helpful factor which tamed the conquerors and saved the heart of the ancient world from the usual effects of an uncontrolled turmoil.

But there was another human and historical factor which affected the movement of the Arabs. We must remember that the Arabs were preceded in the Near East by two other peoples who dominatd the heart of the ancient world — namely the Romans (and Byzantines) and the Persians. The former had a great empire in the west, which endeavoured to establish strong and fruitful commercial relations with the Central East including India and innermost Asia. Greek and other mariners joined hands with Arab traders and mariners to carry on a vast and prosperous trade between the Roman empire and India. This trade had to pass through Arabia where caravans became busy carrying goods from coast to coast. Also Arab mariners from the eastern and southern coasts took an increasingly active part in the maritime trade. Another route of trade was the famous silk-route which went by land from the coasts of the Mediterranean through northern Arabia to the north of Ancient Persia, and yonder to Turkistan and the borders of China. A number of caravan routes crossed Arabia in different directions in order to serve the maritime routes as well as the silk-route. It is perhaps interesting to mention the famous route of Hidjaz which provided livelihood as well as great riches to the tribe of Qureish which commanded Mekka. Another route came from Qateef on the coasts of the Arabian (Persian) Gulf and crossed Nejd and the Nefud desert to Taimaa where it joined the route of Hidjaz. Later on this latter route was superseded by one which started from Charax Spasinu at the head of the Gulf and skirted the Nefud desert to Petra and the Gaza coast. Some time about the 3rd century A.D. the routes of Qateef and Charax were abandoned in favour of a newer and more northerly ones which started from Hira to Bostra, Damascus and Palmyra crossing the middle

and northern parts of the Syrian desert. We have already mentioned at an earlier stage that this northerly shift of the routes may have been at least partly due to gradual desiccation in the southern parts of the Syrian desert. But in spite of the shifts in the routes, there can be no doubt that the land trade which crossed Arabia represented a substantially important source of livelihood for the Arabs. When Rome fell in the 5th century A.D., it was superseded in the field of trade by Byzantium. The Arabs continued to draw great benefits as intermediaries between the two enemies — the Byzantine Romans and the Persians. They also continued to work as mariners and caravan leaders for the rich trade of India. We may well imagine that whatever may have been the consequences of the desiccation, which started in a serious way about the 3rd century A.D. and perhaps reached its present day intensity about the early sixth century A.D., the effect of this desiccation became more or less nullified by the temporary prosperity drawn from trade and transport. Instead of depending entirely upon grazing and little cultivation around wells, a large section of the bedouin population of Arabia was engaged in the activity of transport and trade between east and west. In fact, trade seems to have more than compensated for the impoverishment of the environment. The result was that the outburst from the desert was delayed as long as the income from trade and transportation was maintained.

The trade of the Romans and Byzantines, however, was destined to decline. The great wars between the Byzantines and the Persians weakened both sides and led to a decrease in their purchasing power. At the same time the latter part of the 6th century A.D. seems to have witnessed new changes in the trade policy of the Byzantines. The emperor Justinian (A.D. 527-565) is known to have made a special effort to develop the sea-route of the Red Sea through Ethiopia, in order to establish contacts with the Indian Ocean without passing through Arabia, where trade might be controlled by the Persians. He made a similar effort in order to develop a route from the Black Sea, north of the Caspian, into Central Asia and on to the borders of China. Such changes in the trade policy of the Byzantines must have affected the vital source of the tradesmen of Arabia. The delaying effect which trade and transportation had upon the necessary and preordained outburst from the desert was thus nearing its end.

Finally we must not forget the purely political issue and the consequent military factor. The existence of the two great

powers of the Byzantines and the Persians flanking Arabia on both sides, represented a decisive factor of containment for the Arabs, who had no military strength that could equal either side. The Arabs could not possibly expand outwards as long as the two empires were strong enough to contain them into their desert homeland. The two great powers, however, went on with their suicidal struggle which continued during several centuries. The final result of such a struggle was doomed to lead to the weakening of both giants. The Arabs of those times were the only people who could have benefited from the fatal struggle of the two traditional enemies ; gradually the two empires became too weak to go any further with the fight or even to defend their own frontiers. The new faith gave the Arabs the freshness and strength of spiritual impulse, and they were soon to realise that they were the natural trustees of power in the Near East. When the time came, they overran the Persian empire and became masters of the best parts of the empire of the Byzantines.

Summary and Conclusions:

From this broad survey of the movement of the expansion of the Arabs which took place in the early Islamic phase, we may well see that this important historical phenomenon was not by any means a simple one. Rather was it a complex feature which could only be properly explained if we take into consideration a number of natural and human factors. The weight of evidence seems to point to the conclusion that a climatic change led to the onset of gradual aridity as from the 3rd century A.D., until the crisis reached its climax some three centuries later. Evidences for this aridity may be drawn from archaeological, as well as historical data. The change could not have been quantitatively significant, as Arabia was already in an arid and semi-arid region. Indeed the quantitative change in rainfall could best be traced in south-west Arabia which was always a more rainy plateau. The desiccation which took place had its natural effects upon the life of the bedouins of Arabia. Civil wars between the tribes in this "Period of Ignorance" (before Islam) represented the natural outcome of increasing aridity. Also migrations took place from one part of Arabia to another ; but the main movement of outburst was delayed until the seventh century A.D. Delaying action was due chiefly to human factors. For some time the two empires of the Persians and Byzantines were too strong to allow the bedouins to encroach deep into

the settled lands. For political and military reasons the Arabs were contained into their deserts. Perhaps the sea outlet was the only gateway left free. At the same time the prosperity of trade through Arabia compensated for the dryness of climate. Indeed this represented a period of prosperity for at least some sections of the bedouin community of Arabia. Those who engaged themselves in trade and transportation drew great benefits from this crucial rôle. But prosperity of trade was naturally linked to the prosperity of the consumers especially in the markets of the Mediterranean world. When wars between the Byzantines and the Persians led to decrease in the amount of trade and deviation from the routes of Arabia, the delaying action of the trade upon the outburst from Arabia was nearing its end. At the same time political weakness of the two adjoining empires came soon after the appearance of the new creed. The stage was ready for the people of Arabia to take over the leadership of the heart of the ancient world. Islam came as a subduing and civilizing element, which rendered the movement of expansion both constructive and humane. In this respect both Christians and Muslims in the Arab East seem to have joined hands. There was little conflict between the two religions which were based upon love and fraternity. Even during later phases Islam which benefited partly by political conquests of the Arabs, was never permanently linked in its spread to the military strength of the Arabs. From the southern and eastern shores of Arabia the new creed spread far and wide through simple and peaceful methods of proselytism by mariners and traders. Even in central and eastern Asia, Islam spread chiefly during the Mongul phase which coincided with military weakness of the Arabs. In fact the new creed, once it reached beyond the borders of Arabia, became a world religion which spread under varying circumstances by land and by sea. The expansion of the Arabs gave birth to a movement which led ultimately to the world community of Islam. Thus the expansion of the Arabs represented a phenomenon which had its roots long before the advent of Islam, but did not bear its full fruits until long after the appearance of the new creed.

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PETROLOGICAL STUDY OF PRE-CAMBRIAN MINOR INTRUSIVE ROCKS IN THE NEIGHBOURHOOD OF ASWAN [1]

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ABSTRACT

The pre-Cambrian minor intrusive rocks in the neighbourhood of Aswan are either leucocratic or melanocratic. The leucocratic types are mainly microgranite and granophyre. The melanocratic minor intrusives are basalts and lamprophyres. Basalts are more abundant than lamprophyres and they are composed of plagioclase with either augite or hornblende. The lamprophyres are represented by plagioclase-biotite (kersantite), plagioclase-barkevikitic hornblende (camptonite), and augite-rich (monchiquite) varieties. Bostonites and spessartites are also present but they are relatively rare.

The chemical composition of the basaltic rocks is similar to that of the Whin Sill magma and differs from that of each of the analysed camptonite and nonchiquite. The fractional crystallisation of a basaltic magma is responsible for the formation of the plagioclase-augite, and plagioclase-hornblende basaltic rocks. The latter types originated during relative concentration of water and thus hornblende separated from the differentiating magma instead of augite. The lamprophyres have diversified mineralogical constitution and peculiar geochemical features which cannot be explained by the assumption that they develop from fractional crystallisation of parental basaltic magma. They rather formed through metasomatic reactions taking place between sialic rocks and the basaltic magma. The sialic reactants

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in case of kersantite ; camptonite ; and monchiquite were granite or gneiss ; granodiorite ; and diorite or plagioclase-hornblende-quartz schist respectively.

STATEMENT OF PROBLEM

The origin of the pre-Cambrian minor intrusive rocks in the Eastern Desert has not so far been considered in detail by authors dealing with these rocks. Their chief types are of basaltic and/or lamprophyric natures. The petrogenesis of the latter types is of special interest to petrologists since it is still a matter of controversy.

The present paper is an investigation of the mode of formation of the minor intrusive rocks exposed in the neighbourhood of Aswan, which include varieties of lamprophyric rocks, namely, monchiquite, camptonite and kersantite.

GENERAL DISTRIBUTION AND CLASSIFICATION

Pre-Cambrian minor intrusive rocks are very widely distributed in many regions of the Eastern Desert in the form of dykes cutting the crystalline basement rocks (Hume, 1935 p. 484-580). They are of various composition and texture and the basic types are generally more abundant than the acidic. Schurmann (1953, p. 126-127) named 31 different dyke rocks cutting Gattarian granites in the Eastern Desert. These rocks are chiefly porphyries, porphyrites and lamprophyres. Attia (1948, p. 35-38) described dykes cutting granites in the Barramiya District (between latitudes 25° 3' and 25° 10' N., and longitudes 33° 40' and 34° 5' E.) composed essentially of plagioclase feldspar, brown biotite and other altered ferromagnesian minerals which he classified as andesites. Attia (1948, p. 37) also described an augite andesite porphyry as well as haematised andesite porphyry from this region. Pre-Cambrian post granitic dykes in the Atud District are classified by Amin, Sabet and Mansour (1953, p. 55) as :

1. Basic, including basalts and dolerites,
2. intermediate, including andesites and porphyrites,
3. acidic, including porphyries, granophyres and
4. lamprophyres, including spessartite and camptonite.

The post granitic dykes described by Amin, Mansour, Kabesh and El-Far (1953, p. 30-35) from the Naba District and those studied by Amin, Moustafa and Zaatout (1954) from Abu Diab District, are similar to (a) those of the Atud District (Amin, Sabet and Mansour, 1953) outlined above and (b) those of Gebel El-Ineigi District recently described by Moustafa, Kabesh and Abdulla (1955). Andrew in (Hume 1935, p. 679-684) gives the occurrence and description of bostonites and camptonites in the Eastern Desert and illustrated their main petrographical characters by microphotographs.

The dyke rocks of the studied Aswan District were examined by Ball (1907) who classified them as follows :

1. Quartz felsite,
2. syenite porphyry,
3. enstatite porphyrite,
4. mica-diabase and
5. basalt.

Thus, Ball (1907) did not recognise the lamprophyres of Aswan District described later by Andrew (in Hume, 1935). El-Shazly (1954) in his outline of the rocks of Aswan mentioned that andesites and lamprohyres, chiefly represented by camptonites and bostonites, constitute the dykes in the area under consideration.

The writers classify the dykes of Aswan into two main types on the basis of their colour :

1. leucocratic dykes and
2. melanocratic dykes.

The general distribution of these dykes is shown in Plate 1.

The leucocratic types are. chiefly (i) microgranite and (ii) granophyre encountered at Gebel Tabyet El-Sheikh and Gebel Ibrahim Pasha respectively.

The melanocratic dykes are widely distributed in the area. They are either black, dark green or dark reddish brown in colour. They vary in thickness from 10 cms. to a few metres ; dykes approximately 75 cm. in thickness are common. They may reach several hundred metres in length and show various degrees of alteration. They are vertical and do not differ much in their trend. The common trend of most of the dykes is E-W, to NE.SW. similar to other dykes investigated by Schürmann south of the Hurghada-Quena road and in places in Sinai, for

instance, Gebel Serbal and around Gebel Um Shomer (Schürmann 1953, p. 126-127). Boss-like masses are present in places in the district, for example, near the old golf course (see Plate 1). Series of a few dykes with parallel trend and separated by a few yards can also be encountered. Dyke rocks are more abundant in the Aswan district north of the latitude of Mahata village than to its south. Moreover, the western part of the district is relatively richer in these dykes than its eastern part.

The melanocratic dyke rocks can be satisfactorily classified into :

(i) Plagioclase-hornblende dyke rocks,
(ii) plagioclase-augite dyke rocks,
(iii) plagioclase-biotite dyke rocks,
(iv) plagioclase-barkevikitic hornblende dyke rocks, and
(v) augite-rich dyke rocks.

These dykes cut all the other types of rocks in the area except the Nubian Sandstone which overlies them. Their age, therefore, is Late pre-Cambrian. It is noticeable that basic dykes cutting granites are more abundant than those traversing the schists, whereas, pegmatites are more plentiful in the latter. In places basic dykes can be observed cutting both the schists and granites without any discernible change in their trend in both types. It should be mentioned that the basic dykes cut the pegmatite and are traversed by lamprophyric dykes. The relatively oldest types are, therefore, the basic intrusives.

PETROGRAPHY

The leucocratic dyke rocks are pink in colour and composed essentially of feldspars and quartz intergrown in a distinct micrographic texture in the latter. The microgranite possesses subhedral crystals of orthoclase and plagioclase with the former predominating. Both feldspars are partially altered to kaolin and sericite. It contains dark specks of reddish brown ferriferous material which is seemingly derived after the alteration of an original ferromagnesian mineral. Quartz is present in the interstitial spaces between the feldspars. Flakes of chlorite showing pleochroism with X = pale greenish yellow, Y = Z = pale green are sporadically distributed in the rock. Apatite is present in idiomorphic crystals reaching 0.48 mm. in length. The granophyre, however, is composed essentially of orthoclase and quartz but does not contain ferromagnesian constituents.

The mineralogical compositions of the melanocratic dyke rocks are represented in Table 1. It can be seen that they are chiefly composed of plagioclase and one or more of the ferromagnesian minerals, namely, biotite, hornblende and augite. In rare cases, orthoclase may accompany plagioclase in the rock. The plagioclase-hornblende, as well as the plagioclase-augite dykes, are principally of basaltic nature. Instantly, they possess porphyritic texture with phenocrysts of plagioclase $Ab_{45}An_{55}$ and thus can be satisfactorily classified as porphyrites. However, the rocks which possess biotite or barkevikite-hornblende as their chief ferromagnesian constituent are of lamprophyric nature since they display panidiomorphic texture characteristic for this group. Dyke rocks showing a combination of lamprophyric and basaltic characters are also represented. The accessory minerals which are occasionally met with in all these types are either quartz or olivine. Iron ores and apatite are ubiquitous and are sometimes found in relatively high proportions.

(i) Plagioclase-hornblende dyke rocks.

The dyke rocks which are composed essentially of plagioclase and hornblende are the most frequent types. They are exposed in many places in the district, for instance, approximately 300 metres south west of the English Cemetery, northern end of Gebel Bas, and in the old golf course. They are dark, fine-grained rocks and do not show vesicles or amygdales. Microscopically they are holocrystalline, commonly nonporphyritic and, in places, show subtrachytic texture produced by the sheaf arrangement of their plagioclase crystals. Their essential constituents are plagioclase and hornblende. Plagioclase crystals are subhedral with an average length of 0.64 mm. and form approximately 50 per cent of the modal composition of the rock. They show slight greyish turbidity and their composition is Ab_{45-55} An_{55-45}. Both Carlsbad and albite twinnings are common but zoning was not observed in any of the crystals. A subophitic texture is occasionally produced by the intergrowth of plagioclase and hornblende. Hornblende is bluish green in colour with X = yellowish green, Y = Z = pale bluish green, $Z \wedge C$ 17°. It forms on the Average 40 per cent of the modal composition of the rock and occasionally forms clusters. It shows partial alteration to uralite or chlorite. In places, the central portion

of the hornblende crystal has a black colour due to the presence of very minute grains of iron oxides formed as products of its alteration. Relics of augite within the hornblende crystals are instantly observed indicating that the latter might have been derived after the former. Biotite in these rocks is an accessory constituent. It is brown in colour with X = yellow, Y = Z = dark brown and occasionally borders hornblende. Iron ores represented by both magnetite and ilmenite are present in relatively high amounts reaching approximately 7 per cent of the modal composition of the various studied dykes of this type. Apatite in very small needles is a sporadic minor accessory.

In places, there are dykes which, in general, are similar to those described above and having plagioclase and hornblende as their essential constituents but they show a few petrographic features worthy of notice. A dyke exposed south of Mahata village contains a considerable amount of pleochroic green chlorite with X = pale yellowish green, Y = Z = green. It has a positive elongation and exhibits ultrablue interference colours characteristic of penninite. This mineral appears to be formed after the alteration of hornblende. Another dyke occurring in the old golf course contains appreciable amount of epidote after hornblende. There are dykes in the same area (old golf course) which possess porphyritic structure with phenocrysts of plagioclase $Ab_{50}An_{50}$ embedded in a ground-mass composed of both plagioclase and hornblende. These porphyritic dykes show megascopically phenocrysts of white feldspar ranging in length between 0.48 and 1.76 mm. (Fig. 1). They are often engulfed by the ground-mass matrix material which is composed of fine grains of hornblende, biotite and plagioclase as well as iron ores.

(ii) Plagioclase-augite dyke rocks.

The essential constituents of the plagioclase-augite intrusives are plagioclase $Ab_{50}An_{50}$ and pyroxenes represented frequently by augite and less commonly by augite and hypersthene. The other ferromagnesian constituents, namely, biotite and hornblende may also be found. The representative rock of this group exposed at the road to Mina Sharky is composed of fresh plagioclase containing abundant veinlets of deuteric limonitic material derived from the alteration of the ferromagnesian constituents. The order of abundance of these minerals is biotite, augite and hornblende. Biotite is dark brown in colour and may show bleaching. Augite is purplish grey with $Z \wedge C$ 35°. It exhibits hour glass structure and is accompanied by relatively small amount of hypersthene which distinctly shows pleochroism from pinkish to green colours and displays schillerisation. Both these pyroxene members often have reaction rims of green fibrous hornblende which may in turn be surrounded by dark brown biotite. The pyroxenes may, in places, be replaced entirely by secondary alteration products of calcite, chlorite, haematite and limonite. Bastite pseudomorphs after pyroxene may also be encountered. Quartz is a rare accessory constituent and is present in the interstitial spaces between the other minerals. Apatite in rather long prismatic crystals is relatively abundant. Besides, magnetite and ilmenite are present as minor accessories. Another representative dyke of this group is exposed in El-Hesa Island. Augite, biotite and hornblende form 50, 0.5 per cent respectively of the modal composition of this rock. The optical properties of the constituent minerals and the general petrographical features are essentially the same as those given in connection with the dyke previously described. Southwest of the Ancient Quarries there is a plagioclase-augite dyke rock exhibiting ophitic texture and is composed of approximately equal proportions of plagioclase $Ab_{50}An_{50}$ and pinkish grey augite. Augite is occasionally surrounded by dark brown to black material due to corrosion and reaction with the magma during consolidation. It alters to minute granular material formed of calcite, limonite and haematite. The rock also contains yellowish serpentine pseudomorphs after olivine. These pseudomorphs are accompanied by very fine carbonate material and do not include magnetite veinlets. Biotite in small flakes, abundant magnetite grains and rare apatite laths, are present. There are also a few amygdales filled with calcite. This rock can be satisfactorily classified as basalt.

(iii) Plagioclase-biotite dyke rocks.

In the plagioclase biotite minor intrusives biotite is present in appreciable amounts and may reach 70 per cent of the modal composition of the rock being more abundant than the other essential constituent mineral, namely, plagioclase. Biotite may be accompanied by hornblende or by both hornblende and augite. Dykes of this group are exposed at El-Hesa Island, approximately 200 metres north Khor Umm Buweirat, at approximately 600 metres north west of the aerodrome, and near the old golf course.

They are dark brown in colour and very fine-grained. Microscopically they are holocrystalline and their plagioclase has the composition Ab_{45-50} An_{55-50}. Orthoclase may also be present but is notably less abundant than plagioclase. Biotite is dark brown in colour and may show various degrees of bleaching. It may be present in cases in the form of clusters and may reach 70 per cent of the total modal composition of certain dykes, for instance, those exposed south of Gebel Tegog and at the southern end of Gebel Bas. Hornblende is greenish brown in colour and augite, if present, is in relatively very small amounts and has a greyish colour. At the southwest of the Ancient Quarries there is an interesting dyke rock. It has large porphyritic crystals of quartz, microcline and plagioclase. The ground mass is very fine-grained and composed of biotite, plagioclase and hornblende being the same in composition as the plagioclase biotite minor intrusives. The phenocrysts are undoubtedly accidental xenoliths caught by the magma during its intrusion into the granites which are cut by this dyke. Granites, therefore, played a significant rôle in the development of these dykes as discussed below. In general, the plagioclase biotite types can be satisfactorily classified as kersantites. They can be taken as spessartite whenever hornblende is present in appreciable amounts.

(iv) Plagioclase-barkevikitic hornblende dyke rocks.

The minor intrusives formed of plagioclase and barkevikitic-hornblende are represented by dykes exposed east of the quarry in Gebel Ibrahim Pasha and at the western side of the Aswan Dam Road about 600 metres south of Aswan. They are dark brown in colour and show megascopically needle shaped crystals of amphibole and occasionally possess vesicles as well as amygdales. Microscopically they are holocrystalline and exhibit panidiomorphic texture typical of lamprophyres. Their essential constituents are plagioclase and barkevikitic hornblende. Plagioclase constitutes, on the average, 35 per cent of the modal composition of these dykes. It is generally fresh and has the composition Ab_{55-60} An_{45-40} and occasionally shows slight undulatory extinction. Barkevikitic hornblende has a reddish brown colour with X = light brown, Y = reddish brown, Z = dark brown. It is present in euhedral crystals which instantly show hexagonal outlines. This mineral exhibits alterations of various degrees.

The very highly decomposed grains are frequent and are almost completely replaced by a dark material composed mainly of calcite together with less abundant minute grains of magnetite. Green chlorite and or reddish brown iddingsite after barkevikitic hornblende may be observed. In rare cases sphene can be encountered as an alteration product after this mineral. Orthoclase is present and constitutes, on the average, 5 per cent of the rock. It is found to be stained by a ferriferous brown dust and in places exhibits radial or plumulose arrangement. Biotite is noticeably lacking in this type but quartz is present as an accessory constituent and is found in two types. The first is represented by small intergranular crystals lacking inclusions, whereas, the second is found in the form of rather big crystals which show remarkable reaction effects at their outer margins and occasionally exhibit spectacular micrographic intergrowths with orthoclase. This texture is very well developed in places of the rock where it closely resembles a granophyre. The big quartz crystals are likely to be accidental xenoliths caught by the magma from the intruded granitic rocks. Similar zenoliths were found in the case of some plagioclase biotite kersantitic rocks discussed above. The quartz xenoliths of the barkevikitic-plagioclase camptonitic rock were converted to granophyre through transfusion and reaction with alkaluminous material (Fig. 4). Calcite veins are occasionally observed in these rocks. It is noticeable that the crystals of barkevikitic hornblende, in close proximity to these veins, are completely altered being replaced by deep reddish brown iron oxide pseudomorphs. The amphibole crystals at a distance from the vein are less decomposed. Amygdales are frequently met with and are composed of calcite, quartz and zeolites. Amygdales formed of two of these minerals are not uncommon. Pseudomorphs of iron oxide after barkevikitic hornblende can also be seen in close neighbourhood and surrounding the amygdales.

The lamprophyric dykes exposed at Biga Island are composed of feldspars represented chiefly by orthoclase showing turbidity and stained by reddish iron oxide dust. Plagioclase constitutes a very small proportion of the rock. The only ferromagnesian constituent present is a reddish brown to brownish green variety of biotite. It is generally bleached and, therefore, shows different shades of colour throughout the whole length of the crystal. Quartz as an accessory constituent is present in the interstitial spaces. Magnetite and apatite are minor acces-

sory constituents of the rock. This lamprophyre dyke is very likely a bostonite.

(v) Augite-rich dykes.

A dyke exposed at the southwest of the Ancient Quarries exhibits dark green colour and possesses abundant amygdales of mainly calcite. Microscopically it is composed almost entirely of purple titaniferous augite. This mineral is present in phenocrysts as well as smaller crystals in the ground mass. The crystals are idiomorphic and may reach 1.44 mm. in length. The phenocrysts exhibit twinning and hour glass structure. They are occasionally surrounded by a narrow rim of dark brown biotite. Phenocrysts of serpentine pseudomorphs after olivine are present in subordinate amounts. They show a yellowish green core and a very pale green peripheral portion and may occasionally contain a very finely dessiminated material which is possibly talc. Biotite is dark brown with X = pure yellow, Y = Z = dark brown and present as an accessory constituent. The groundmass contains very small crystals of plagioclase and calcite as well as isotropic greyish material which is possibly analcite. Magnetite and apatite are the minor accessories. The amygdales are formed chiefly of calcite and less frequently of quartz. Numerous calcite veins can be seen in its different parts. This rock is the most melanocratic type amongst the studied minor intrusive dykes of the district, and is classified as porphyritic monchiquite.

CHEMICAL COMPOSITION

Table 2 shows the chemical analyses of representative rocks of each of the plagioclase-hornblende and plagioclase-augite basaltic intrusives, camptonite and porphyritic monchiquite, as well as a mica diabase given by Hume (1935). The Niggli Values of the recently analysed dykes, as well as their corresponding normative compositions, were calculated and listed in Tables (3) and (4) respectively. The equivalent molecular percentages (Niggli, 1936) were used in calculating the normative compositions of the analysed rocks.

Table (2) shows that the analysed dykes are either ultrabasic or basic since their SiO_2 contents range between 38.91 and 47.73 per cent. The Na_2O content of the analysed camptonite (4.51 per cent) is higher than that of each of the other analysed

dykes (2.26 - 3.49 per cent). In general, the Na_2O content exceeds that of K_2O in all the dykes except the porphyritic monchiquite which has a slightly higher K_2O content (2.77 per cent) than that of Na_2O (2.26 per cent). It is noticeable that both TiO_2 and P_2O_5 are relatively high reaching 4.11 and 1.43 per cent respectively. Both the camptonite, which has amygdales as well as veins of calcite, and the porphyritic monchiquite, which possesses abundant calcite in its groundmass, have relatively high contents of CO_2 being 2.97 and 2.78 per cent respectively. On the other hand, the contents of this oxide in the basaltic dykes are low being 0.42 per cent and nil.

There are appreciable differences especially in TiO_2, Na_2O and K_2O contents of the analysed camptonite of the Aswan District and that of Wadi Mellaha, Eastern Desert, given by Hume (1935, p. 553). The former possesses higher content of TiO_2 (4.11 per cent) and lower amounts of each of Na_2O and K_2O (4.51 and 1.93 per cent respectively than the latter (TiO_2, 2.13; Na_2O, 5.88; and K_2O, 2.35 per cent). On the whole, the composition of the analysed camptonite of Aswan is not markedly different from that of the average camptonite given by Daly (1933), and has MgO (5.10 per cent), CaO (7.92 per cent), Na_2O (4.51 per cent) and K_2O (1.93 per cent) contents similar to those of a camptonite dyke from Skaergaard peninsula (4.59, 7.48, 4.23 and 1.96 per cent respectively) given by Vincent (1953, Table III, analysis VII).

The chemical composition of the analysed porphyritic monchiquite of Aswan is similar to that of a monchiquite from Hopi Buttes, northeast Arizona given by Turner and Verhoogen (1951, p. 336, analysis 1) in their table of the compositions of typical lamprophyres. Most of the constituent oxides in both rocks are close to each other, except K_2O which reaches 2.77 per cent in the Aswan monchiquite and is as low as 0.43 per cent in that of Hopi Buttes, Arizona. The high K_2O content in the former can be accounted for by its relatively abundant biotite.

The chemical composition of the plagioclase hornblende basaltic dyke is similar in many respects to that of the Whin Sill magma (Holmes and Harwood, 1928) and that of the Deccan basalts (Washington 1922). Their total FeO + Fe_2O_3 are 12.84, 12.37 and 13.11 per cent respectively. Their MgO; and CaO contents are 5.66, 5.42 and 5.46 per cent; and 8.72, 9.09 and 9.45 per cent respectively. The MgO/CaO ratio is 0.64 in the analysed dyke, 0.60 in the average Whin Sill magma and 0.58 in the

average Deccan basalts. Their alkali contents are 4.06, 3.38 and 3.32 per cent respectively and they all have higher Na_2O content than that of K_2O. The chemical composition of the analysed plagioclase-augite basaltic dyke is not notably different from that of the plagioclase-hornblende basaltic minor intrusive. It is significant to notice that the Niggli Values calculated from the average chemical composition of basalts (Daly, 1933) are closely similar to those of the average of the analysed basaltic dykes of the district under consideration (see Table 3 columns 6 and 7). Their al, fm, c and alk values are 22.47, 22 and 9 respectively in the former and 22, 47, 22 and 10 respectively in the latter.

PETROGENESIS

There are differences between the chemical, as well as the normative compositions of the basaltic rocks on the one hand and those of each of the camptonite, the porphyritic monchiquite and the mica diabase on the other hand, (see Tables 2 and 4). These differences would become more conspicuous if the plagioclase biotite kersantitic, the bostonitic, as well as other unanalysed dykes, are taken into consideration. It is reasonable to assume that the original magma from which such different dykes were formed was basaltic in composition since basaltic rocks are predominant in the district. The fractional crystallisation of this magma gave rise to the mica diabase as well as the other types which are chiefly of basaltic nature. This process can be evidenced by the presence of reaction rims of hornblende and/or biotite surrounding augite in some of these dykes. The presence of hornblende instead of augite in some basaltic dykes in the area can be explained by relatively high concentration of water responsible for the formation of amphiboles, instead of pyroxenes during the differentiation of the magma. The origin of the other dykes, especially the lamprophyric types, can hardly be explained on the assumption that differentiation of basaltic magma alone gave rise to such rocks. It would be difficult to understand the mode of fractionation of the residual melt into monchiquitic, kersantitic, bostonitic and camptonitic compositions. However, the presence of xenocrysts of microcline and quartz in the kersantite and of the latter mineral in the camptonite bears witness to the fact that the rocks containing these minerals must have been involved in the process of development of the lamprophyres. The basaltic magma, by reaction with certain xenocrysts of the invaded sialic crystal materials, can give rise to particular compositions similar to those of the lamprophyric rocks. The diversity in the composition of the sialic materials in the Aswan District (granites, granodiorites, diorites, hornblende- and biotite-schists), as well as in the relative proportions of the reactants, would naturally result in the production of lamprophyres of such different compositions that cannot be developed by the fractional crystallisation of a basaltic magma alone. The relative proportions $FeO + Fe_2O_3 : Na_2O + K_2O : CaO + MgO$ of the analysed dykes as well as some representatives of their intruded rocks, namely, granodiorites, diorite and hornblende-schist, the chemical analyses of which are given in Table 5, are graphically shown in Fig. 5. It can be seen that the reaction between the average composition of the two analysed basaltic dykes, which is considered to represent the original magma and the analysed diorite, would result in the development of the porphyritic monchiquite. The analysed hornblende-rich schist has a chemical composition similar to that of the diorite (see Table 5). It could, therefore, give rise to monchiquite through metasomatic reactions with the original basaltic magma. Moreover, the reaction between this magma and either of the analysed granodiorites would result in the formation of the camptonite. Undoubtedly, the relative proportions of these reactants would differ in the various reactions as can be seen in Fig. 5. Similarly, the reaction between this magma and sialic rocks relatively rich in K_2O, such as the granites and gneisses, would form rocks essentially of kersantitic nature. It is significant to mention that the above reactions are only examples and there could have been others but the reactants are substantially the same in every case, namely, basaltic magma and sialic crustal material. Other rocks originated by the reaction of the sialic material with a magma, are the volcanic ultrabasic potassic types of South Western Uganda and the adjoining part of the Belgian Congo. These types have diversified compositions similar to the case of the studied lamprophyres and they were originated by reactions between a carbonatitic magma and granites and other rocks of the sialic crust (Higazy, 1954).

CONCLUSIONS

The pre-Cambrian minor intrusive rocks of Aswan are chiefly of basaltic and lamprophyric natures. The basaltic dykes are composed essentially of plagioclase, augite and hornblende and have chemical compositions similar to those of Whin Sill and Deccan basalts. The lamprophyres are represented by monchiquite, camptonite, spessartite, kersantite and bostonite. They possess xenocrysts of quartz and microcline of the intruded plutonic rocks. The quartz xenocrysts show transfusion phenomena and are converted into granophyre. The original basaltic magma gave rise by fractional crystallisation to the various basaltic dykes. The lamprophyres, however, were originated through metasomatic reactions taking place between the original basaltic magma and the sialic crustal material. The variation in the composition of the sialic rocks and in the relative proportions of the reactants were responsible for the derivation of the different varieties of lamprophyric rocks. Camptonite, kersantite and monchiquite resulted from reactions between basaltic magma and granodiorite, granite or gneiss, and diorite or hornblende-schist respectively.

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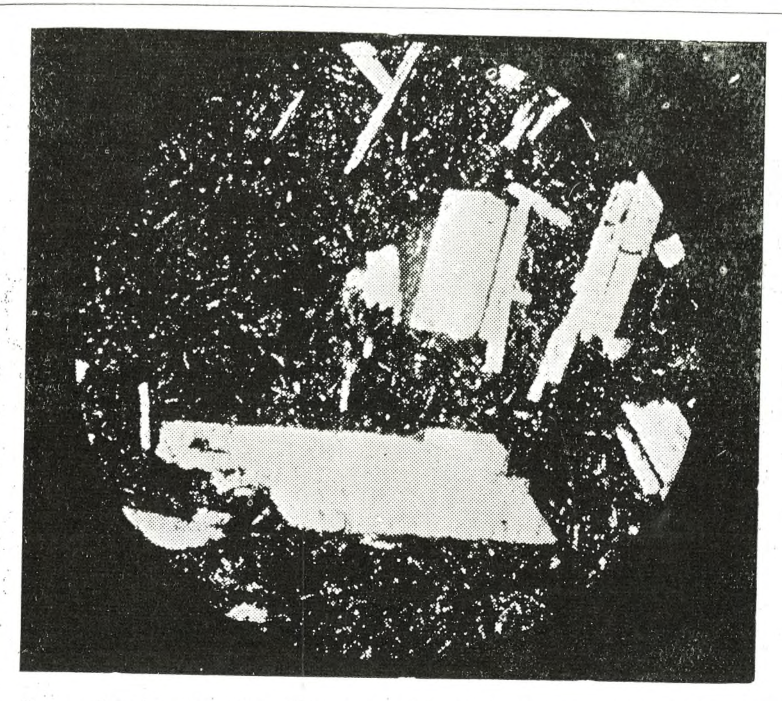


Fig. 1. — Porphyrite (No. 50) from old golf course. Microthin section, P.P.L. 38 X. Note plagioclase phenocrysts (white) and fine-grained groundmass of hornblende, iron-ore (black) and plagioclase (white).



Fig. 2. — Basalt (No. 84) from El-Hesa Island. Micro-thin section, P.P.L. 14 X. Plagioclase (white), augite and iron-ore (dark).

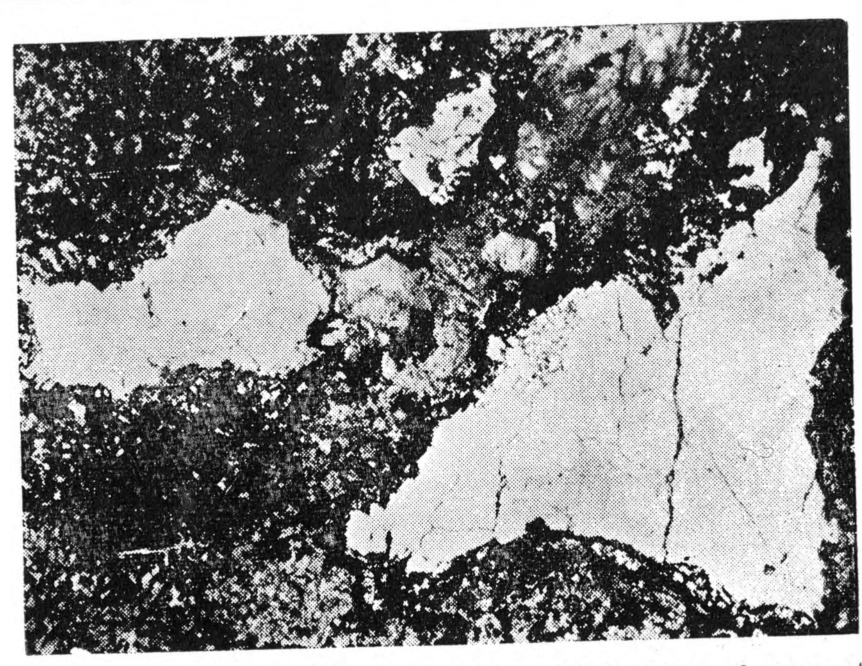


Fig. 3. — Quartz xenocryst in camptonite (No. 37) from East of quarry at Gebel Ibrahim Pasha. Micro-thin section, P.P.L. 11 X.

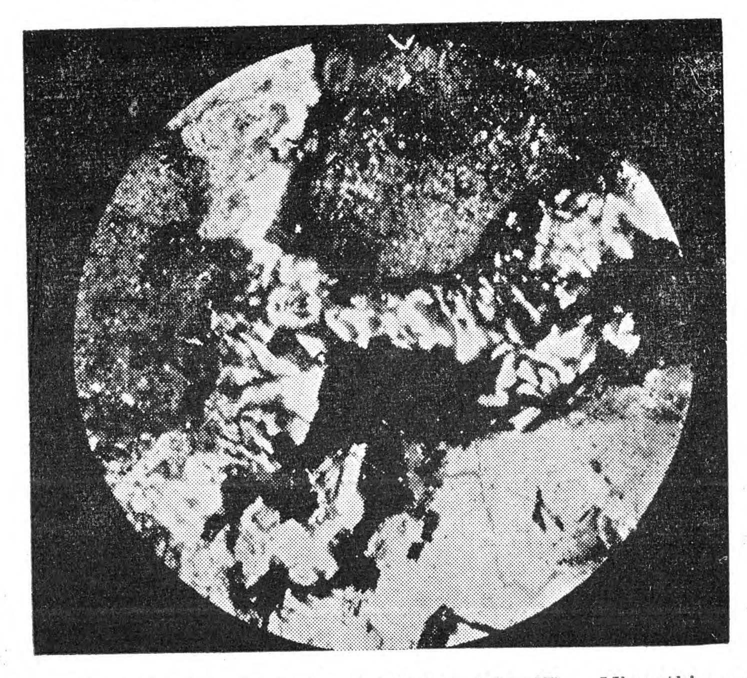


Fig. 4. — Micrographic texture in camptonite (No. 37). Micro-thin section, C.N. 70 X.

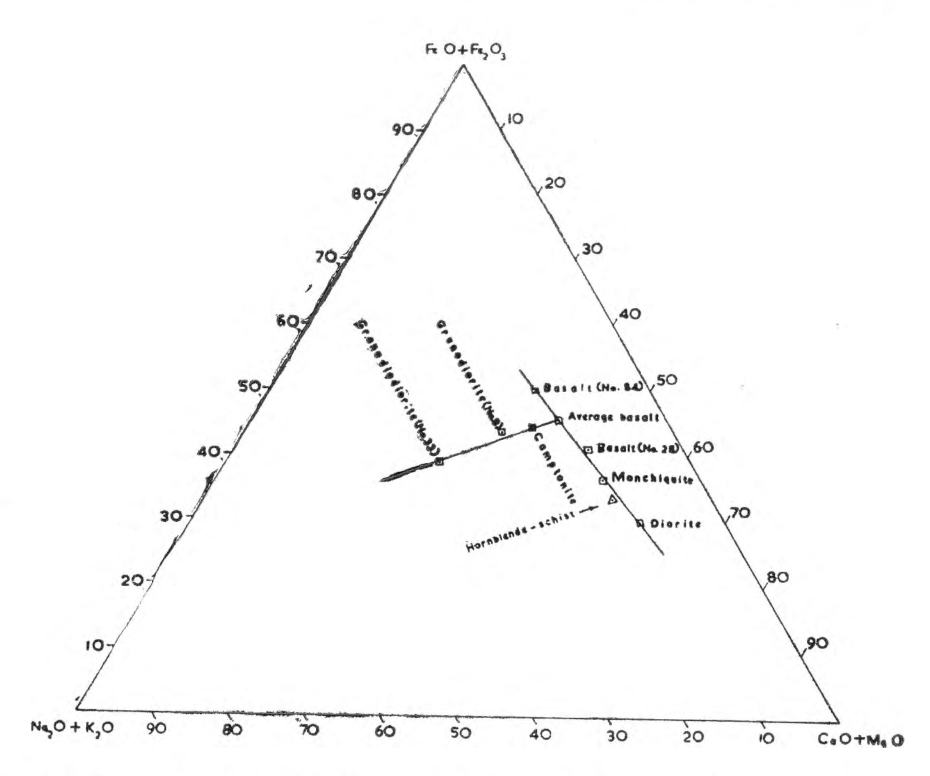


Fig. 5. — Relative proportions of FeO + Fe_2O_3, Na_2O + K_2O, and and CaO + MgO of the analysed basalts, camptonite and monchiquite; and granodiorite, diorite and plagioclase-hornblende-quartz schist. Note that camptonite lies between average basalt and granodiorite while monchiquite lies between average basalt and both diorite and analysed hornblende-schist.

TABLE 1.

Mineralogical Composition of Dyke Rocks. [1]

feldspar	plagio-clase	plagio-clase (potash feldspar)	plagio-clase	plagio-clase	plagio-clase	plagio-clase	plagio-clase (potash feldspar)	plagio-clase (potash feldspar)	plagio-clase	plagio-clase
ferro-[2] magne-sian constituents	horn-blende (biotite)	horn-blende (biotite)	biotite horn-blende	biotite	biotite augite horn-blende	augite (biotite horn-blende)	barke-vikite horn-blende (biotite)	bleached biotite	biotite	augite biotite

([1]) Minerals in brackets are present in subordinate amounts.
([2]) Minerals are arranged according to their relative abundance in the different rocks.

TABLE 2.

Chemical Analyses of Dyke Rocks.

	A	B	C	D	E	Average A & B	Average basalt
SiO_2	47.14	47.73	38.91	41.45	55.62	47.44	49.06
TiO_2	2.69	3.72	2.59	4.11	1.78	3.20	1.36
Al_2O_3	15.60	13.79	10.70	13.54	11.87	14.70	15.70
Fe_2O_3	5.31	5.95	6.33	9.79	2.66	5.63	5.38
FeO	7.53	9.67	8.22	5.70	8.56	8.60	6.37
MnO	0.18	0.24	0.26	0.19	0.20	0.22	0.31
MgO	5.66	3.99	9.59	5.10	4.07	4.83	6.17
CaO	8.72	7.04	10.64	7.92	11.25	7.88	8.95
Na_2O	3.49	2.96	2.26	4.51	1.57	3.23	3.11
K_2O	0.57	1.74	2.77	1.93	5.52	1.16	1.52
H_2O^-	0.35	0.44	0.72	0.31	0.30	0.40	1.62
H_2O^+	1.44	1.19	2.94	1.77	0.86	1.32	
CO_2	0.42	—	2.78	2.97	—	0.22	—
P_2O_5	1.00	1.43	1.23	1.02	0.29	1.22	0.45
Other constituents	—	—	—	—	1.05	—	—
Total	100.10	99.89	99.94	100.31	100.60	100.05	100.00

Analyst: E. Christensen.

A) Plagioclase hornblende basaltic dyke (No. 28) from Gebel Bas.

B) Plagioclase augite basaltic dyke (No. 84) from El-Hesa Island.

C) Porphyritic monchiquite dyke (No. 53) from southwest of the Ancient Quarries.

D) Camptonite dyke (No. 37) from east of the quarry at Gebel Ibrahim Pasha, eastern side of Aswan Dam Road.

E) Mica diabase, analyst: H.F. Harwood in (Hume and Harwood, 1925). Other constituents include, S. 1.05; SrO, none; BaO, none and Li_2O, trace. Less O for S, 0.39. Total 100.21.

TABLE 3.

Niggli Values of the Analysed Dyke Rocks

	A	B	C	D	E	Average A & B	Average basalt
al	22	21	13	17	19	22	22
fm	46	48	55	54	42	47	47
c	23	20	24	18	34	22	22
alk	9	11	8	11	5	10	9
si	114	124	81	86	152	119	115
k	0.10	0.28	0.45	0.22	0.19	0.19	0.24
mg	0.45	0.32	0.55	0.29	0.40	0.39	0.52
qz	- 22	- 19	- 51	- 61	30	- 21	- 19

Analyst: E. Christensen.

TABLE 4.

Normative Compositions of Analysed Dyke Rocks.

	A		B		C		D		Average A & B	
quartz	0.7		4.8		—		—		2.8	
orthoclase	3.5		11.0		17.0		12.0		7.3	
albite	32.0	$Ab_{55}An_{45}$	28.5	$Ab_{58}An_{42}$	13.5	$Ab_{54}An_{46}$	37.0	$Ab_{78}An_{22}$	30.3	$Ab_{57}An_{43}$
anorthite	26.0		20.0		11.3		10.7		23.0	
nepheline		—		—	4.4		3.0			—
wollastonite	3.8	7.6 diopside	2.8	5.6 diopside	6.8	8.4 diopside	1.4	2.8 diopside	3.3	6.6 diopside
enstatite	16.4	17.2 hypersthene	11.6	14.8 hypersthene	1.6		1.4		14.0	16.0 hypersthene
ferrosilite	4.6		6.0		5.2			—	5.3	
forsterite		—		—	19.6		10.0			—
magnetite	5.7	9.7	6.5	12.1	6.9	10.7	5.4	14.6	6.1	10.9
ilmenite	4.0		5.6		3.8		5.8		4.8	
haematite	—		—		—		3.4		—	
apatite	2.1		3.2		2.7		2.1		2.7	
calcite	1.2			—	7.2		7.8		0.6	

A — E as in Table 2.

TABLE 5.

Chemical Analyses of Granodiorites, Diorite and Plagioclase-Hornblende-Quartz Schist of Aswan District.

	A	B	C	D
SiO_2	54.19	60.56	46.04	47.42
TiO_2	2.49	1.58	2.10	1.47
Al_2O_3	14.30	14.15	22.36	21.27
Fe_2O_3	3.22	2.23	0.99	1.55
FeO	8.26	6.24	7.47	7.86
MnO	0.20	0.16	0.16	0.16
MgO	2.91	1.78	4.94	3.53
CaO	5.93	4.33	11.64	11.54
Na_2O	3.51	3.83	2.39	3.05
K_2O	2.45	3.33	0.62	0.74
H_2O-	0.12	0.09	0.13	0.88
H_2O	0.95	0.64	0.79	0.73
CO_2	—	0.29	0.27	0.26
P_2O_5	1.38	0.85	0.09	0.25
Total	99.91	100.06	99.99	99.91

Analyst: E. Christensen.

A = Coarse-grained porphyritic granodiorite (No. 8) from Gebel Tegog.

B = Coarse-grained porphyritic granodiorite (No. 33) from north of the English Cemetery western side of Aswan-Dam road.

C = Diorite (No. 98) from the eastern portion of the district north Khor Um Buweirat.

D = Plagioclase-hornblende-quartz schist (No. 75) from the ancient railway cutting, south of the Aswan town.

THE PLACE OF ZITTEL'S "OVERWEGISCHICHTEN" IN THE UPPER SENONIAN STRATIGRAPHY

With A Note On The Provincial Affinities Of Its Fauna (Type Area: Kharga Oasis) [1]

by

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I. — INTRODUCTION

The fossiliferous strata overlying the Nubian Sandstone and clays in the Kharga Oasis and the South Western Desert in general, show a dual classification. The older, or the pre-nummulitic division of the series, is a heterogeneous succession of neritic shallow water and frequently phosphatic deposits indicating an unstable epicontinental shelf. The newer, or nummulitic division, is mainly composed of pure limestones and yellowish marls without sandy or clayey beds suggesting deeper water conditions. The strata of the pre-nummulitic division in the Kharga Oasis have been the subject of detailed investigation and fossil-collecting by the writer. The result of this has enabled to define their proper position in the scale of Upper Senonian stratigaphy, to attempt a scheme for their zonining and to elucidate the provincial affinities of their fauna. These strata have been generally attributed wholly to the Danian Stage (Zittel : 1883 ; Ball : 1900 ; Quaas : 1902 ; Wanner : 1902 ; Hume : 1911). Blankenhorn (1900, pp. 32-33), used the term Maestrichtian for the lower part of the division ; but he identified it with Lower Danian, Dordonian and Upper Aturian. In a later work (1921) he referred the same beds to the Campanian, ignored the Maestrichtian and placed the remainder of the beds in the Danian which he considered to be part of the Senonian. Fourtau (1904, p. 235), in a discussion of the Senonian, believed the

(1) Communication présentée en séance du 23 avril 1956.

Dordonian of Coquand (1857, p. 749) to be equivalent not only to the Maestrichtian of Dumont (1849, p. 361) but also to a part of the Danian, and recommended that the term Dordonian be dropped. The Upper Senonian would thus include the campanian as its lower horizon and the Maestrichtian as the upper, while the Danian is an independent stage on the top of the Senonian. Fourtau, in the same work, also reasoned that the limit between the Maestrichtian and the Danian in Egypt should be drawn at the top of the highest beds with ammonites in the Libyan Desert. This means that the beds with *Exogyra Overwegi* and *Libycoceras* are relegated to the Maestrichtian which is considered as a substage of the Senonian. Some modern authors now tend to treat the European Maestrichtian as an independent stage between the Senonian and the Danian and place it equal in rank to the Senonian. A survey of the modern literature has been given by Jeletzky (1951, p. 198) who also supports the idea of an independent Maestrichtian Stage in general, and in Europe in particular, "simply because there are no known equivalents of the Maestrichtian, neither in the type area of the Senonian Stage of D'Orbigny (1842, 1852), nor in the type locality of the Campanian Stage of Coquand (1857 a - b)." North African stratigraphers, however, still treat the Maestrichtian as the topmost substage of the Senonian. According to Laffitte (1934, p. 1437 & 1939, pp. 244 & 246) the lower limit of the Maestrichtian substage in North Africa is marked by the appearance of *Orbitoides tissoti* Schlum, *Bostrychoceras polyplocum* Roemer and *Libycoceras ismaeli* Zittel, and heralds the last phase of the great and uninterrupted Senonian transgression over the north of the African continent, Syria and Palestine, and is also noticeable in many other regions. The upper limit of the Maestrichtian is marked by the appearance of the guide fossil *Libycoceras chargense* Blankenhorn, by *Sphenodiscus* spp. and by the abundance of *Exogyra overwegi*. Usually following this horizon conformably are beds with *Cardita beaumonti* D'Archiac, which Laffitte considers as Danian.

In the Kharga Oasis, no typical Campanian fossils have been recorded in the pre-nummulite strata (2) and the fossiliferous

(2) In a recent trip to the Oasis (Feb. 1955); Prof. G.H. Awad and the writer, have discovered a new fossiliferous horizon at the base of the lowest zones of the Maëstrichtian as given in this work. The material is now under study and may prove to be of Campanian age.

succession has always been considered as beginning with the so-called *Exogyra overwegi* series or the "Overwegischichten" of Zittel. At the base of these beds, the writer has discovered a fossiliferous horizon containing among other fossils specimens of *Bostrychoceras polyplocum* and *Nostoceras* sp. (sp. nov. ?). The faunule from this horizon suggests a Lower Maestrichtian age. For palaeontological and other reasons discussed below, the beds with *Cardita libyca* (Quaas) which form the highest horizon of the "Overwegischichten" are considered here to belong to the top of the Upper Maestrichtian rather than to the Danian. The part of the pre-nummulitic succession overlying the *C. libyca* horizon in the Kharga Oasis appertains to another stage, the Danian or Dano-Mountain, which is transitional in character and different in all respects from the Senonian and from the overlying Paleocene. The fauna, age and palaeoecology of this stage will constitute the subject of a later paper.

II. — STRATIGRAPHY

The following is a description of the succession as measured and studied in the Gebel El-Ter and Tarwan range to the north of the Village of Kharga. Confirmatory sections were also studied at Gebel Um El-Ghanayem and other localities. Commencing with the lowest horizon the ascending succession is as follows:

I. Brown ochreous sandstone of moderate hardness, externally of dark colour due to desert varnish. The rock is densely current-bedded. No base for this horizon has been seen in this locality.
.... Thickness 30 ms. plus.

II. Dark green, compact, ochreous, siliceous clay with salt-veins and containing many iron concretions assuming various shapes and sizes. The bed yielded no fossils of any kind except for one fossil fruit.
.... Thickness 5 ms.

III. Hard yellowish phosphatic band with small flinty concretions and fish teeth of various forms, e.g., *Otodus biauriculatum* Zittel and *Otodus* sp.
.... Thickness 3 ms.

IV. Dark grey unfossiliferous, finely laminated clay.
.... Thickness 20 ms.

V. Phosphatic band, similar to horizon III, in which a tooth of *Otodus smilodon* Zittel has been identified.
.... Thickness 3 ms.

VI. Dark grey clay with intercrossing gypsum-veins, passing upwards into a thin, brown, hard, limestone full of minute lamellibranch shells, foraminifera and some unidentifiable fossils, and recalling the appearance of glazed brown porcelain.
.... Thickness 0.2 ms.

VII. Grey, well-bedded, finely laminated, marly clay. The horizon contains moderately sized internal moulds of lamellibranchs, gastropods, cephalopods and small tests of sea-urchins. The characteristic fossile *Isocardia chargensis* Mayer-Eymar is present in large numbers. Other fossils identified include *Chama callosa* Noetling, *Chama* sp., *Crassatella zitteli* var. *typica* Quaas, *Isocardia chargensis* Mayer-Eymar, *Veniella (Roudairia ?), gibba* sp. nov., *Arca* sp., *Chlamys mayer-eymari* (Newton), *Turritella sexlineata* Roemer, *Natica* (Gyrodes) *farafrensis* Wanner *Eutraphoceras desertorum* Quaas, *Baculites anceps* Lamarck, and *Baculites anceps* var. *libyca* var. nov. (3)
.... Thickness 13 ms.

VIII. Reddish brown marls containing iron oxides and full of casts of *Exogyra overwegi* together with *Lucina saharica* Quaas, *Protocardia moabitica* Lartet. *Veniella (Roudairia) duri* var. *ponderosa* var. nov., *Spondylus* sp., *Plicatula instabilis* Stoliczka, *Plicatula aschersoni* Zittel, *Exogyra overwegi* v. Buch, *Turritella sexlineata* Roemer, *Baculites* cf. *anceps* Lamarck and *Hoplitoplacenticeras awadi* sp. nov. (4)
.... Thickness 8 ms.

IX. Unfossiliferous greenish grey clay.
.... Thickness 3 ms.

X. Dirty brown argillaceous limestone with an excellent fossil content of lamellibranchs, gastropods and cephalopods. *Chama callosa* Noetling, *Chama* sp., *Crassatella zitteli* var. *typica* Quaas, *Crassatella zitteli* var. *lucinoides* Quaas, *Cardita libyca* (Quaas), *Veniella (Roudairia) drui* var. *ponderosa* var. nov., *Macrocallista ? rohlfsi* (Quaas), *Macrocallista (Callistina) rostro-centralis* sp. nov., *Cucullaea schweinfurthi* Quaas, *Exogyra overwegi* v. Buch and *Arca (Nemodon) esnaensis* Newton have been identified.
.... Thickness 5.5 ms.

(3) The description of the new species mentioned here is included in a paper on the systematic palaeontology of the "Overwegischichten" which is under preparation.

XI. Unfossiliferous greenish grey clay.
.... Thickness 2.5 ms.

XII. Marly, fragmental earthy limestone containing abundant shells of *Cardita libyca*. *Cardita libyca* (Quaas), *Crassatella zitteli* Wanner var. *typica* Quaas, *Arca (Nemodon) esnaensis* Newton, *Exogyra overwegi* v. Buch, *Delphinula zitteli* Quaas, *Scalaria schweinfurthi* Quaas, *Natica (Euspira) tarensis* sp. nov. (5) and *Pugnellus africanus* Quaas have been collected.
.... Thickness 7 ms.

Study of the Succession.

Horizon I represents the well-known sandstone of the Nubian Series which surrounds the downthrown mass of the Tarawan-Ter chain and forms the foot of the Taref Plateau. At Gebel El-Taref, where the Nubian Sandstone is best developed, the lower horizon is predominately sandy while the upper portions are clayey. Near the top of the clays thin phosphatic bands are developed, which are also clearly seen at the foot of the Tarawan-Ter chain represented by horizons III & V. The Nubian beds are almost devoid of fossils, except for a very few fossil tree-stems and fruits, and pass conformably to the higher fossiliferous strata.

The rarity of organic remains, the diachronic character, and the striking lithological uniformity have conspired to lead to much confusion regarding the range in age of the Nubian Sandstone. Lately, it has been pointed out that the age could be ascertained from the immediately overlying strata provided that there is no uncomformity. In the Kharga Oasis the first fossiliferous strata above the Nubian beds are of Maëstrichtian age and there is no sign of an unconformity. No fossiliferous strata immediately underlie them and thus the range in age of the Nubian Series could not be determined; all that can be strated is the Nubian beds in the Kharga Oasis may be of Campanian age and possibly extend up into the Maëstrichtian.

The overlying phosphatic horizons III & V are also exposed at Gebel El-Taref, Ghanima and Um El-Ghanayem. They may represent a period of exceedingly slow deposition at the base of the prenummulitic strata. The *Overwegischichten* (horizons VI

(4) The description of the new species mentioned here is included in a paper on the systematic palaeontology of the "Overwegischichten" which is under preparation.

to XI) are a conformable sequence of the upper clays of the Nubian Series, marked by the development of marly and calcareous bands. They pass insensibly upwards into the Lower Esna Shales in such a manner that it is difficult to draw a sharp line of demarcation between the two. The limestone and marl bands increase in number in the upper portion of the Overwegi beds and become more fossiliferous and crowded with myriads of *Exogyras* and other fosils.

III. — ANALYSIS OF THE FAUNA AND ZONING OF THE SUCCESSION

The few brachiopods are of little stratigraphical value, but all come from the Upper Senonian and chiefly from the Campanian and Maëstrichtian of India. *Inoceramus* [6] and *Veniella* are characteristic Cretaceous genera that did not survive the Maëstrichtian; *Exogyra overwegi* and *Veniella (Roudairia) drui* are typical of the topmost Senonian in many places. On the other hand, the presence of *Cardita libyca* suggests a correlation high up in the Maëstrichtian as does likewise the abundance of species of *Crassatella, Chama* and *Macrocallista*. The gastropods are all Upper Senonian species; chiefly significant among them is the strictly Maëstrichtian species *Turritella sexlineata* of Maëstricht (the type locality) and of other places in Northern Europe. The type of ornamentation in the gastropods, particularly in *Scalaria schweinfurthi* has a striking Tertiary look. Among the cephalopods, *Eutrephoceras desertorum* is an interesting species similar to forms from the Upper Senonian of France as well as the Lower Eocene of England. *Libycoceras ismaëli* unfortunately not found by the writer but described by Quaas (1902, p. 302, pl. 29 & 30, figs. 3-7) from the Overwegi beds, is now a well known Maëstrichtian guide-fossil in Africa and the Middle East. Related forms are restricted also to the Maëstrichtian in India, Soudan, Somaliland and other places.

A consideration of the distribution of the fauna in the Maëstrichtian rocks in the Oasis permits their division into three zones which are first recognized and established by the writer.

(5) *Inoceramus cripsi* Mantell is recorded from these formations by Quaas (1902, p. 170).

Zone A. The index species is *Isocardia chargensis,* which is ubiquitous in the Oasis, restricted to the base of the succession and present in great numbers and could be regarded as a guide-fossil for the zone. Also most of the fossils mentioned in the *Isocardia* bed do not extend upwards. Characteristic ammonite species of this zone are *Bostrychoceras poplyplocum* and *Nostoceras* sp. Other important fossils are:

Trigonoarca of *glandrina, Chlamys mayer-eymari, Nautilus desertorum* and *Baculites anceps.*

Zone B. The index species is *Exogyra overwegi* which begins to be the most abundant and outstanding fossil, and some of the bands are made up of this fossil. Other characteristic forms are *Plicatula instabilis, Plicatula aschersoni, Veniella (Roudaireia) drui, Crassatella zitteli, Cardita libyca* and *Hoplitoplacenticeras awadi.*

Zone C. The index species is Cardita libyca. This is not so abundant in the last zone as here, where its increase in numbers is almost proportional to the decline in *Exogyra overwegi.* Gastropods predominate over lamellibranchs and genera not represented in the lower zones make their appearance. No ammonites have been recorded from this zone. Other important fossils which appear in this zone are:

Arca esnaensis, Delphinula zitteli, Natica terensis and *Scalaria schweinfurthi.*

The association of *Turrilites (Bostrychoceras) polyplocum, Baculites anceps* and *Nostoceras* sp. in the lowest zone indicates early Maëstrichtian age. The ammonites are extremely rare in the second zone and are represented only by one species of *Hoplitoplacenticeras* which is a strictly Upper Senonian genus. Not a single ammonites has been found in the third zone which is crowded with *Cardita libyca.*

The upper lilit of the Maëstrichtian in the Kharga Oasis is difficult to draw because there is a perfect upward gradation in lithology. But the presence of an horizon characterised by the appearance of *Cardita libyca* and the disappearance of *Exogyra overwegi* may be taken as marking end of the Maëstrichtian.

The accompanying analytical and correlation table of the fauna shows the vertical distribution of the species identified. It also shows the occurrence of the identical and related forms in different localities of the Indo-Pacific Upper Cretaceous as

compared with ocurrences elsewhere in other provinces of deposition. The close affinity of our fauna chiefly to forms from the Indo-Pacific Maëstrichtian is clearly seen.

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ANALYTICAL AND CORRELATION LIST OF THE MAESTRICHTIAN FAUNA IN THE KHARGA OASIS

Names of Fossils	Age	Occurrence of identical or related forms in the Indo-Pacific Region						Names of related forms from the Indo-Pacific Region	Occurrence of elated forms from other than the Indo-Pacific Region
		Ar	Bl	Md	SA	Pn	NA		
Rhynchonella cf. *plicatiloides* Stol.	A.	r	r					*R. plicatiloides.*	
Terebratula cf. *subrotunda* Sowerby.	A.	r						*T. subrotunda.*	*T. subrotunda* (English Chalk).
Lucina saharica Quaas.	B.	r		r			*	*L. fallax* Forbes.	*L. concentrica* Lam. (Paris Basin, Eocene).
Chama callosa Noëtling.	A.B.		*						
Chama sp.	B.	r						*C. callosa* Noëtling.	
Crassatella zitteli Wanner.	A.B.C.D.			*		r	*	*C. rothi* Fraas.	
Crassatella chargensis Quaas.	B.	r							
Crassatella nilotica sp. nov.	B.	r						*C. macradonta* Sow.	
Protocardia moabitica (Lartet).	B.				r	*	r	*P. biseriata* Perving.	
Cardita libyca (Quaas)	B.C.							*C. beaumonte* D'Arch.	*C. beaumonti* D'Arc. (N. America, Midway).
Isocardia chargensis Mayer-Eymar.	A.								
Veniella (Roudairia) druui. (Munier-Chalmas)	B.		r	*	*	r	*	*R. crassoplicata* Noet. *R. undata* Conrad.	
Veniella (Roudairia) gibba sp. nov.	A.								
Macrocallista rholfsi (Quaas)	B.	r			r		r	*Cytheria discoidalis* Stol. *M. zululandensis* Rennie. *M. euglypha* Woods. *C. tissoti* M.-Chalmas.	
Macrocallista (Callistina) *rostro-centralis* sp. nov.	B.	r						*C. minuta* Stoliczka.	
Arca (Nemodon) esnaensis Newton	C.			*	r			*A. (N) natalensis* Baily.	
Cucullaea schweinfurthi Quaas.	B.D.						*		*C. glabra* D'Orb. (U. Senonian, Europe).
Trigonoarca cf. *glandrina* D'Orbigny	A.	*		*					
Chlamys mayer-eymari (Newton).	A.B.C.D.					*	*		
Plicatula aschersoni Quaas.	B.								
Plicatula instabilis Stoliczka.	B.	*		*					
Spondylus sp.	B.								
Spondylus cf. *dutempleanus* D'Orb.	A.								*S. dutempleanus* D'Orb.
Exogyra overwegi Von Buch.	B.C.			*	*	*	*		
Delphinula zitteli Quaas.	C.	r						*D. jacobi* Basse.	
Natica farafrensis Wanner.						*	*		
Natica (Euspira) terensis sp. nov.					r			*N. multiseriata* Baily.	
Scalaria schweinfurthi Quaas.		r			r			*S. shutanurensis* Stol. *S. ornata* Baily.	
Turritella sexlineata Roemer.	A.								*T. sexlineata* Roemer. (Chalk of Maestricht).
Pugnellus africanus Quaas.	A.			*					
Cypraea kayei Forbes	A.D.	*							
Nautilus desertorum Zittel.	A.D.						*		
Baculites anceps Lamark	A.			*		r	*	*B. palestinensis* Picard.	
B. anceps. war. *libyca* var. nov.	A.					r	r	*B. anceps, B. palestinensis, B. anceps.*	
Turrilites (Bostrychoceras) *polyplocum* Roemer.	A.	*		*		r	r	*T. aff. punicum* Perv. *T. punicum* Perv.	
Nostoceras? sp. nov.	A.								
Hoplitoplacenticeras awadi sp. nov.	B.	r						*H. adoorensis* (Stoliczka).	
Xenohelix cf. clarki Mansfield	A.								*X. clarki* Mansfield (Mexico, Miocene).
Otodus biauriculatus Zittel.	A.								*O. appendiculatus* Agassiz. (Up. Cret. N. Germany).
Otodus smilodon Zittel.	A.								
Otodus sp.	A.								

Ar = Arialoor formation (Campanian & Maëstrichtian of Southern India.)
Bl = Baluchistan (Maëstrichtian formations of Mari Hills in Western India.)
Md = Madagascar (Upper Senonian; chiefty Maëstrichtian of Eastern Coast.)
SA = South Africa (Upper Senonian; chiefty Maëstrichtian of Pondoland, Zululand & Angola.)
Pn = Palestine (Upper Senonian; chiefly Maëstrichtian of Judean Desert.)
NA = North Africa (Maëstrichtian & Danian of French N. Africa; Chiefly Tunisia & Algeria.)
* : represents identical species.
r : represents related species.
A, B & C represent zones of the Maëstrichtian in the Kharga Oasis.
D : represents occurrence in next stage Danian or Dano-Montian.)

PETROGENETIC SIGNIFICANCE OF THE TRACE ELEMENTS IN THE SPANGO PLUTONIC COMPLEX (SOUTH SCOTLAND)

by

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ABSTRACT

The trace elements of the granodioritic rocks of the Spango complex, South Scotland, have been determined spectrographically. The distribution and relative proportions of the determined elements appear to be consistent with the hypothesis that the investigated rocks are metasomatic in origin.

INTRODUCTION

The Spango complex, which is probably of Old Red Sandstone age occurs on the border of Dumfriesshire and Lanarkshire. Walker (1928) summarises earlier work concerning this complex, and mentions that its main rock is a basic hornblende-biotite-granodiorite or quartz-diorite showing very little variation. He favoured the derivation of the rocks from a magma of quartz-dioritic composition. Sarkar (1948) gives a detailed geological map of the area, showing the distribution of the main granodioritic rock of the complex as well as its surrounding sediments, together with detailed petrographic descriptions and chemical analyses of the rocks. His observations led him to conclude that the granodioritic types of the complex are products of metasomatic-metamorphism of the aureole sediments. The trace-element contents of representative samples of this complex

have now been determined spectrographically by the writer in order to study the significance of these elements in solving petrogenetic problems.

SPECTROGRAPHIC ANALYSIS AND DATA OBTAINED

Representatives of the Spango complex rocks were kindly provided by Professor Arthur Holmes for the spectrographic determination of their trace elements, using the semiquantitative method described in detail by Mitchell (1948). The determined trace elements, and the wave lengths of their respective diagnostic lines have already been recorded by the writer (Higazy, 1952a). The rocks include :

No. of rock	*Name*
S/186	Metamorphosed mudstone
S/41	Cordierite-biorite-hornfels
S/162E	Biotite-amphibole-plagioclase-hornfels
501/D	Porphyritic micro-diorite
501/G	Hornblende-biotite-granodiorite

The chemical analyses of these rocks are assembled in Table 1a, while their trace-element contents are given in Table 1b.

General Geology

The Spango granitic complex and its metamorphic aureole comprise Ordovician and Lower Old Red Sandstone rocks. Their sequence can be summarised as follows :

Lower Old Red Sandstone		Lava conglomerate. Red Sandstone. Contemperaneous flows of andesite and olivine-basalt and ash beds.
		Plutonic complex; granodiorite and diorite. Minor dykes of porphyrite (metamorphosed).
Ordovician	Caradocian	Greywackes, mudstones and Haggis rocks. Glenkiln black shales.
	Arenig	Radiolarian cherts and mudstones

The Ordovician sediments are folded along axes with the normal Caledonian trend, south-west to north east. The folds form part of the north western flank of the great anticlinorium which is the dominating structure of the Ordovician and Silurian sediments in the Southern Uplands.

The plutonic complex is elliptical in form (3 1/4 × 1 1/4 miles), with the major axis approximately parallel to the strike of the Ordovician sediments. The width of the metamorphic aureole varies from 1/6 of a mile to 1 1/3 miles in the different parts (Sarkar, 1948).

Metamorphosed porphyritic dykes of Lower Old Red Sandstone age cut the Ordovician beds within the metamorphic aureole. They are earlier than the plutonic complex.

General Petrography

(i) Arenig cherts and mudstones.

The Arenig group is formed of radiolarian cherts of different colors interbedded with mudstones. The unmetamorphosed chert is composed of crypto-crystalline silica with various bands containing ferruginous and argillaceous material (Sarkar, 1948, p. 18). Different grades of metamorphosed chert are represented. The low grade types contain quartz, minute flakes of biotite, small octahedra of magnetite, rare garnet and incipient cordiorite. In the medium-grade the minerals remain the same but increase in grain size. Orthoclase, plagioclase, diopside and enstatite appear in the high-grade types in addition to the minerals already mentioned.

The unmetamorphosed mudstones are composed chiefly of fine chloritic and sericitic material, minute grains of quartz and ferruginous matter (Sarkar, 1948). Together with these constituents, the analysed sample (S/186) contains small needles of rutile and grains of zircon. In the low-grade metamorphosed

mudstones minute blebs of pale green biotite appear, together with occasional acicular, colorless or pale green amphibole and incipient crystals of cordierite. The medium-grade types consist of cordierites of irregular shape in a matrix of brown biotite and minute quartz grains. Sample S/41 is representative of this type. The high-grade types consist of dark brown flakes of biotite; cordierite, occasionally showing pleochroic haloes; acicular or lamellar crystals of amphibole; and skeletal enstatite.

(ii) The Caradocian group.

The Caradocian group is composed of (a) pebbly grits (Haggis rocks) and (b) greywackes and mudstones.

(a) A general description of the constituent pebbles, fragments and grains of the Haggis rocks is given by Sarkar (1948, p. 43). The chief materials present include quartz, feldspars and amphiboles, Arenig cherts and mudstones; and spilites, andesites, alkali-trachytes, micro-granites, granophyres and tuffs. The groundmass in which these different ingredients are embedded, consist of a much finer-grained matrix of similar materials. The spilitic, andesitic and other volcanic pebbles closely resemble those found in the Arenig rocks of the Southern Uplands.

As a general rule, the metamorphism of the Caradocian sediments increases towards the margin of the granitic complex, but numerous exceptions have been observed (Sarkar, 1948). In places, conspicuous enrichment of the Haggis rocks in hedenbergite and plagioclase is noticeable. This enrichment is believed to be brought about by introduction and fixation of the cafemic constituents (Sarkar, 1948, p. 71).

(b) The detrital constituents of the Caradocian greywackes vary in size from 0.1 to 2.0 mm. The grains are subangular in the coarser greywackes and angular in the finer types. They are composed of materials similar to those in the Haggis rocks.

Quartzo-feldspathic pods and lenticles exhibiting granitic texture are occasionally present in the metamorphosed greywackes. The hornfels surrounding these pods and lenticles shows relative enrichment in biotite.

The Caradocian mudstones are similar in composition to the Arenig types; and the similarity naturally extends also to the different metamorphic products (chiefly cordierite-biotite-hornfels). Hornfelses unusually rich in biotite are notably developed.

(iii) The plutonic complex.

The Spango complex is composed mainly of granodiorite with a subsidiary development of diorite. The two types are intimately connected and inclusions of dioritic composition of variable size are ubiquitous in the granodiorite.

Two varieties of diorite are recognised by Sarkar: a porphyritic micro-diorite which exhibits crystalloblastic textures and a medium-grained diorite which is also of more even grain.

The most significant feature in the plagioclases and biotites of these diorites is their striking similarity to those developed in the highgrade hornfelses near the margin of the complex. Moreover, relics of fine-grained hornfelsic material arranged either zonally or at random are commonly met with in the plagioclases of the diorites (Sarkar, 1948, p. 113). The detailed mineralogical study carried out by Sarkar of numerous samples of diorite and aureole hornfelses shows that all transitional stages between these two extreme types are commonly represented.

The granodiorites are fine- to medium-grained hornblende-biotite-bearing varieties with abundant dark colored hornfelsic and dioritic inclusions. These inclusions vary in size from a few millimetres to several yards across, and in shape from round or elliptical to irregular. Their contacts with the granodiorite are usually sharp. Both the granodiorite and its inclusions have plagioclase and biotite with respectively similar characters (Sarkar, 1948, p. 157). Orthoclase forms up to one-third of the total feldspars in the granodiorite and commonly contains relics of plagioclase with textures indicating that it was formed at the expense of the plagioclase. The approximate modes of the analysed granodiorite (501/G) and diorite (501/D), as recorded by Sarkar (1948, p. 177) are:

	Porphyritic micro-diorite	*Granodiorite*
Quartz	4.7	22.1
Plagioclase	57.6	42.5
Orthoclase	4.2	14.5
Amphibole	12.1	10.6
Biotite	18.5	8.9
Pyroxene	0.5	0.3
Accessories	2.0	1.0
	99.6	99.7

Petrogenesis

(i) Field and petrological evidence.

Walker (1928) accepted the traditional magmatic origin for the Spango complex. Under this hypothesis, the diorite and granodiorite are interpreted as successive differentiation products of a single magma. Sarkar (1948), however, reports a wealth of field and petrographic evidence which is completely inconsistent with such a mode of origin. The predominant textures of the diorite and granodiorite are crystalloblastic. Many of the feldspars of both these types contain hornfelsic relics as inclusions. In addition, plagioclase crystalloblasts exhibiting properties similar to those of the rocks of the complex are widely distributed in the hornfelses of the aureole. The biotites have properties similar to those of the adjoining hornfelses. Such features obviously cannot be explained by magmatic processes; they are, however, consistent with a metasomatic mode of origin.

Detailed study of the hornfelses reveals that in some places they become enriched in cafemic constituents (basified), while in others they become enriched in feldspathic constituents, culminating in the formation of rocks of dioritic and/or granodioritic composition (granitisation). A typical sequence worked out by Sarkar (1948) to illustrate successive stages in the evolution of granodiorite from mudstone is:

(S/186) mudstone (S/41) cordierite-biotite-hornfels (S/162E) biotite-amphibole-plagioclase-hornfels (basified hornfels) (501/D) porphyritic micro-diorite (501/G) biotite-hornblende-granodiorite.

(ii) Geochemical evidence.

The geochemical migrations and fixations of the major elements involved in the transformation processes have been found by Sarkar (1948) to be similar to those established by D.L. Reynolds (1946) for basification and granitisation processes.

As demonstrated by the data recorded in Table 2b the trace-element contents of the diorite and granodiorite are also inconsistent with a magmatic ancestry of these rocks. In the first place, their respective contents of Cr (120 and 90 ppm.) and V (130 and 110 ppm.) are very much higher than those of felsic rocks developed by magmatic fractiomation; the latter, as would be expected, are found to contain negligible amounts of these elements ((Higazy, 1952b). Moreover, the relation Cr Ni Co, which characterises both the diorite and granodiorite, is different from that of late magmatic differentiates; these have less Cr than either Ni or Co (Lundegardh, 1949; Higazy, 1952b). The fact that the country sediments of the Spango complex have the same relation (Cr Ni Co) strongly suggests that the sediments played an essential rôle in the development of diorite and granodiorite.

The behavior of the trace elements in the basification and granitisation processes by which the rocks of this complex developed is also highly significant. Chemical and trace-element compositions of the grey-wackes — which played as essential a rôle in the development of the diorite and granodiorite as the hornfelses — are unfortunately lacking. In the absence of such data, the exact behavior cannot be recognised. Judging by the hornfels data, however, basification and granitisation involved introduction of Rb, Zr, Sr and Y (see Table 2b). Table 2b also shows that the total of Li, Cr, Ni, Co, Cu and V in the average basified hornfelses (931 ppm.), is higher than the corresponding average for diorite and granodiorite (389 ppm.). This follows the behavior of the corresponding replaceable major elements, namely, Mg, Fe_2 and Fe_3, for which the respective totals are 9.58 and 5.75 per cent. Moreover, the total of Rb, Ba and Sr in the average granitised types (4360 ppm.) indicates an enrichment of

these elements relative to their abundance in the basified types (3735 ppm.). This is in accordance with the total of K and Ca, which is higher in the diorite and granodiorite (5.39 per cent) than in the basified hornfelses (4.07 per cent). The major elements, therefore, were followed in a general way by the trace elements which are known to replace them in favorable crystal lattices. The data are too few for firm conclusions to be drawn, but it is worthy of notice that the pattern of behavior is similar to that found by the writer in other metamorphic and metasomatic rocks (Higazy, 1952a; 1953; 1954a and 1954b).

CONCLUSIONS

The chief rocks of the Spango complex are diorite and granodiorite. These types show textural and petrographic characters which favor a metasomatic origin. Moreover, they have very much higher Cr and V contents than magmatic types of similar composition, and have the relation Cr Ni Co which is inconsistent with a magmatic origin.

The relation Cr Ni Co persists in the granitic types of the complex; the same relation characterises the country rocks. This strongly suggests that the country rocks have played an essential rôle in the development of the granitic rocks.

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Table 1a.

Chemical composition of the chief rocks of the Spango complex.

	A S/186	B S/41	C S/162E	D 501/D	E 501/G
SiO_2	56.62	57.26	54.24	58.68	65.18
Al_2O_3	17.88	18.42	18.03	17.57	16.93
Fe_2O_3	2.64	0.24	0.96	1.17	0.94
FeO	6.74	7.82	8.08	4.96	3.42
MgO	5.72	4.71	5.72	3.64	2.18
CaO	tr.	1.64	3.19	5.66	2.63
Na_2O	2.04	2.65	4.02	3.64	3.53
K_2O	2.58	2.69	2.94	2.79	3.04
H_2O —	4.27	2.45	0.87	0.96	0.98
H_2O —	0.49	0.48	0.16	0.05	0.14
TiO_2	0.87	1.37	1.26	0.84	0.72
P_2O_5	0.06	0.07	0.06	0.07	0.04
MnO	0.17	0.05	0.14	0.09	tr.
Total	100.08	99.85	99.67	100.12	99.73

Analyst: W.H. Herdsman.

A Unmetamorphosed mudstone, near Fingland Farm, about 900 ft. from the Knochenshag diorite (Sarkar, 1948, Table 1, analysis 1).

B Cordierite-biotite- hornfels, a metamorphosed mudstone of medium-grade, 250 ft. from the Knochenshag diorite border (Sarkar, 1948, Table 1, analysis 2).

C Biotite-amphibole-plagioclase-hornfels from near the Bucht Hill diorite margin (Sarkar, 1948, Table 1, analysis 3).

D Porphyritic micro-diorite inclusion within the granodiocrite, from the right bank of Brocklaw Burn (Sarkar, 1948, Table 1, analysis 4).

E Hornblende-biotite-granodiorite, from the right bank of Brocklaw Burn (Sarkar, 1948, Table 1, analysis 5).

Table 1b.

Trace-element contents in ppm. of the chief rocks of the Spango complex.

Element	Sensitivity	A S/186	B S/41	C S/162E	Average BC	D 501/D	E 501/G	Average DE
Rb	1	85	150	220	185	180	140	160
Li	1	70	500	100	300	90	80	85
Ba	5	1700	1200	2800	2000	2200	2000	2100
Sr	5	120	600	2500	1550	2200	2000	2100
Cr	1	160	180	350	265	120	90	105
Co	2	30	25	50	38	30	15	23
Ni	2	150	150	190	170	60	30	45
Zr	10	180	200	280	240	1000	800	900
La	30	*	30	30	30	30	40	33
Y	30	70	90	150	120	160	120	140
Cu	3	30	50	5	28	10	12	11
V	5	110	120	140	130	130	110	120
Ga	1	35	35	45	40	35	40	37
Tl	30	*	*	*	*	*	*	*
Sn	5	*	*	*	*	*	*	*
Pb	10	10	20	10	12	10	12	11
Sc	10	10	20	25	23	12	10	10
Mo	1	1	1	2	1.5	*	*	*
Ge	10	*	*	*	*	*	*	*
Be	5	*	*	*	*	*	*	*
Ag	1	*	1	*	*	3	4	3.5
In	10	*	*	*	*	*	*	*

Analyst: R.A. Higazy.

(*) Element if present is in amounts considerably less than its limit of sensitivity.

A — E are as given in Table 1a.

TECTONICS OF EGYPT AS ANTICIPATED FROM FACIES OF SEDIMENTATION (1)

by

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ABSTRACT

The different types of the Egyptian sediments are discussed. The pre-Cambrian meta-sediments are mainly slates, greywackes and conglomerates They belong to the geosynclinal facies and mark intense orogenic movements. The Paleozoic and Mesozoic sediments are chiefly autochthonous limestones and orthoquartzitic sandstones belonging to the epirogenic facies (platform). They indicate relative crustal stability during these eras. The Tertiary sediments, however, are a mixture of platform facies sediments and of conglomerates. They are suggestive of minor crustal movements taking place principally in Cretaceous-Eocene, early Middle Eocene, late Middle Eocene, late Upper Eocene, Oligocene, late Oligocene-early Miocene, late Middle Miocene, late Miocene-early Pliocene and late Pliocene.

INTRODUCTION

The sedimentological studies of Bailey (1930 and 1936), Jones (1938), Krynine (1941) and Pettijohn (1943) have clearly shown that tectonics govern the petrographical features of the different types of sediments. Moreover, Pettijohn (1949) emphasizes that sediments which form during the three tectonic stages, namely, the early geosynclinal (peneplanation), geosynclinal and post-geosynclinal (faulting) belong to the epirogenic (platform), orogenic (geosynclinal) and post-orogenic facies of sedimentation respectively. The present paper deals with the classification of

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the Egyptian sediments according to the facies concept, with emphasis on their relation to tectonics prevailing during their formation.

PRE-CAMBRIAN SEDIMENTS

According to Hume (1935, p. 652) the Metarchean rocks of Egypt include fine sediments and contain abundant intrusive sills of dioritic and porphyritic composition. Moreover, he (Hume, 1935) mentions that the Eparchean sediments are composed chiefly of slates, conglomerates and breccias with fragments of granites and andesites. Consequently, such sediments are obviously polymictic in composition. The recent investigations of the Egyptian Geological Survey also indicate that the folded metamorphosed pre-Cambrian sediments of the different regions of the Eastern Desert are principally conglomerates, slaty rocks and greywackes.

In Gebel Ineigi District, Moustafa, Kabesh and Abdulla (1955, p. 9) found that the metasediments of Bint Abu Quraiya are massive mudstones, as well as granulites (argillites) and slate-greywackes, becoming prominent in Wadi El-Miyah and Gindi-Daghbag Districts. Among the rock fragments represented in these sediments are : metamorphosed arenites and argillites, fine-grained granite and trachyte.

It is important to notice that Amin, Sabet and Mansour (1953) in their description of the mudstones of Atud District, mention that these rocks represent a group of fine arkosic mudstones and are composed of quartz and feldspar grains, with an average diameter of 0.01 mm., together with chloritic matter. These features are obviously suggestive of the greywacke nature possessed by these sediments. Moreover, these authors (Amin, Sabet and Mansour, 1953) state that there is gradational relationship between the mudstones and the metamorphic schists of Atud District. This fact would imply that the latter types also have greywacke affinities. Besides the muddy sediments of this district, there are varieties of proper greywacke as well as others of conglomerate. The latter are widely distributed and their fragments reach 20 cm. in diameter and, in places, their thickness approaches 30 meters (Amin, Sabet and Mansour, 1953).

The important feature of the presence of iron bands intercalated with pre-Cambrian metasediments in Abu Diab District (Amin, Moustafa and Zaatout, 1954) should not be overlooked. The iron-rich rocks of this district (Abu Diab) exhibit features similar to those of Wadi El-Karim near Kosseir, Wadi Abu Lassaf and Wadi Um Hagalig studied by Attia (1949). They vary in thickness south of Gebel El-Maiyit (Abu Diab District) from a few centimetres to 10 metres. They form discontinuous bands of magnetite which, in places, are associated with others of jasper. It should be stated that magnetite-chert formations are known to be represented in the geosynclinal sediments of (1) Timiskaming age in different parts of the U.S.A. and (2) Upper Huronian of Upper Michigan (Pettijohn, 1943). The pre-Cambrian metasediments of Naba District (Amin, Mansour, Kabesh and El-Far, 1953) and Umm Lassaf District (Amin and Mohamed, 1954) are similar to those of the above-mentioned districts.

In general, the pre-Cambrian metasediments in the Central Eastern Desert (Amin, 1955) comprise (1) Eparchean-Metarchean amphibolites, mudstones and related greywacke and conglomerate mixed with metavolcanics, ortho-green schists and pyroclasts and (2) Post Gattarian purple slates, greywackes and polymictic conglomerates.

Igneous intrusions, volcanicity, migmatization and granitization are all well established phenomena which took place during the pre-Cambrian. Moreover, arenaceous rocks which possess orthoquartzitic nature, as well as autochthonous limestones, are lacking. Dolomitic rocks, however, are represented but they are related genetically to the serpentinites and talc-carbonate rocks (baramites) and they are not products of dolomitization of original limestones. Cross bedding and ripple marks which are commonly met with in the sediments of the platform facies are not encountered in the pre-Cambrian metasediments. All these features lead us to the belief that the Egyptian pre-Cambrian sediments belong to the geosynclinal facies of sedimentation. They resemble the rock associations known from the Middle and Upper Huronian of the Upper Peninsula of Michigan, the Lower Paleozoic of Wales and the South Highlands of Scotland, the Jurassic of the Coast Ranges of California, the Triassic of Alaska and the Tertiary of the Alps. All these occurrences are known to mark strong diastrophism. It can be mentioned, therefore, that the pre-Cambrian in Egypt, as evidenced from its sediments, is an

era of remarkable orogeny and great crustal movements accompanied by folding, mountain building and rapid erosion and deposition.

PALEOZOIC-MESOZOIC SEDIMENTS

The contrast between the pre-Cambrian sediments on the one hand, and those of both the Paleozoic and Mesozoic, on the other, is very striking. The latter eras are characterised by surprising predominance of orthoquartzitic sandstones, limestones and marls; and lack of greywacke, feldspathic arenites and thick polymictic conglomerates as discussed below.

The marine Lower Paleozoic sediments have not, so far been recorded with certainty in Egypt. The Carboniferous is, however, recognized at Gebel Owenat (Western Desert), Wadi Araba, Wadi Abu Darag (Eastern Desert) and Umm Bogma in Sinai (Farag, 1953). Ball (1939) mentions that the Carboniferous seas spread over far larger areas than those covered by Carboniferous rocks. Moreover, he (Ball, 1939) states that the basal beds of the Nubian Sandstone may possibly belong to the Carboniferous period, or may even be of an earlier age. On the whole, the Carboniferous in Egypt is composed mainly of beds of limestones and dolomites between two series of sandstones with noticeable ripple marks in the upper series. Glauconitic marls are encountered in places, for instance, Abu Darag (Farag, 1953). Moreover, manganese ores are present intercalated with the Carboniferous formations in Sinai.

Marine Permian formations are not known so far in Egypt. However, some of the unfossiliferous Nubian Sandstone may be Permian in age.

It can be stated, therefore, that the Paleozoic deposits in Egypt belong to the platform facies of sedimentation. They are composed fundamentally of autochthonous limestones and orthoquartzitic sandstones which occasionally possess ripple marks. Such sediments indicate that (1) the Paleozoic was an age of relative crustal stability and (2) erosion and deposition were of slow rate during this era.

Triassic sediments occur at Gebel Areif El-Naga in Eastern Sinai (Awad, 1945). They comprise mainly of limestones, marls, gypsiferous clays, sandstones and dolomites (Awad, 1945).

The Jurassic formations are more widely distributed than those of the Triassic. They are to be found in Gebel Maghara, Gebel Minshera (Northern Sinai), Northern Galala Plateau-Sukhna, Ras El-Abd, Wadi Am Lug and Wadi Araba on the scarp facing the Gulf of Suez (Farag, 1941, 1948 and Nakkady, 1955). They are represented mainly by limestones, chalk, oolites, dolomites, marls, sandstones and shales. The sandstones are occasionally cross bedded.

The Cretaceous rocks cover approximately two fifths of the surface of Egypt. They comprise Nubian Sandstone, chalk, limestones, marls, clays, phosphatic beds and iron formations. According to Higazy and Wasfy (1956), the Cretaceous Nubian Sandstones of Aswan District contain negligible amount of feldspars (less than 5 per cent). The sandstones may possess glauconite and, in places, are represented by orthoquartzitic conglomerates. The limestones are mainly autochthonous. They are often dolomitized and/or silicified and may have chert nodules or bands. Arkosic sediments, greywackes and polymictic conglomerates are not widely recroded in this period. However, the arkosic conglomerate bands at the base of the Mesozoic Nubian Sandstones exposed in a few localities in the Eastern and Western Deserts and the Nile Valley (Sandford, 1935 and Farag, 1953), are thin and, therefore, should not be considered of the tectonic type.

It is obvious, therefore, that the Mesozoic sediments of Egypt, similar to those of the Paleozoic, belong to the platform facies of sedimentation. This would imply that marked tectonic movements did not take place during this era and that peneplanation accompanied by slow deposition prevailed.

TERTIARY SEDIMENTS

The Cretaceous-Eocene relation features an interesting problem in the stratigraphy of Egypt. The detailed character of the contact between these two periods is beyond the scope of the present work. It can be stated, however, that unconformity marked mainly by conglomerates has been recognized by several investigators in different places, for instance, Abu Roash, Bahariya Oasis and Gebel Maghara. In those localities, the conglomerates separate either the Cenomanian or the Maestrichtian

from the Middle or Upper Eocene. There are other places however, (Wadi Abu Durba in Sinai, Gebel Duwi in the Eastern Desert, Tramsa-Tukh in the Nile Valley at Qena and the Farafra Oasis in the Western Desert) where continuity in sedimentation was recorded between the two periods under consideration (Farag, 1953). Moreover, Shukri (1954) gives data, provided by Oil Companies of Egypt, which confirm the presence of both these contrasted relationships between the Cretaceous and the Eocene in different places of the Western and Eastern Deserts and Sinai. Our knowledge concerning the detailed petrographic features of the Cretaceous-Eocene conglomerates is still meagre. However, these conglomerates, wherever they ar present, seem to mark a relatively slight tectonic movement. It is interesting to find Picard (1943) stating that the Syrian Arcs orogenic movement took place in post Cretaceous ages. This movement would account for the modification in the type of sedimentation facies from typical platform in pre-Upper Cretaceous times to conglomeratic deposits encountered in places between the Upper Cretaceous and the Eocene. Moreover, Hassan (1951) in his study of the palaeontology and stratigraphy of the Maestrichtian-Paleocene of Kharga Oasis, came to the conclusion that the Syrian arcs uplift seems to be responsible for the formation of an euxinic sea south of the NE-SW Syrian ridge. Thus Paleocene shales characterised, in places, by the presence of dwarfed fauna (euxinic facies) were deposited.

The Eocene sediments cover at least one fifth of the surface of Egypt. They belong to the Lower Eocene, Middle Eocene (Lower Mokattam) and Upper Eocene (Upper Mokattam). The Lower Eocene is represented by limestones which often contain chert nodules and bands, marls and shales; the latter are, in places, of Paleocene age. The Middle Eocene sediments are mainly chalk and limestones. The Upper Eocene rocks are noticeably different from those of both the Lower and Middle Eocene. They comprise sandstones and marls of brown ochreous colour, with occasional intercalations of limestones and chalk. Moreover, limestones and gypsiferous clays overlain by ferruginous sandstones with lignite and plant remains are encountered near Qasr El-Saga (Farag, 1953).

Eocene conglomerates, other than those forming the unconformity between the Mesozoic and the Tertiary, are also met with. Conglomerate beds were recorded in the Lower Mokattam by Cuvillier (1929). A thin conglomerate intervenes between the Middle Eocene and the Upper Eocene at Qait Bey (Farag, 1953). A conglomerate band was found above the Lower Eocene deposits at Khodeid El-Dib dome (eastern coast of the Gulf of Suez).

The Oligocene sediments cover only 1.5 per cent of Egypt's surface and its deposits are markedly different from those of the Eocene. They comprise chert pebbles and gravels, unfossiliferous sandstones, grits, travertines and silicified wood fragments. In addition, both fluviatile and marine Oligocene deposits are encountered in places. The former are represented by alternating sands, marls and calcarenites, while the latter are composed of limestones, sandy marls and calcarenites with invertebrate fossils. It is interesting to find that the Oligocene rocks in Egypt include volcanic types, mainly of basaltic nature encountered in several regions, for instance, Bahariya Oasis, Gebel Katrani, Abu Roash, Abu Zaabal, Cairo-Suez road and Wadi Araba. Reference should be made to Andrew (1937) for the detailed geographical distribution of these Tertiary basaltic rocks in Egypt. Moreover, hydrothermal activities started in late Oligocene resulting in the formation of hard iron-stained quartzites in Gebel Ahmar and Gebel El-Nasuri District (Shukri and Akmal, 1953) and continued during post Oligocene times as discussed in detail by Shukri (1933). However, Ismail and Farag (1956) recorded hydrothermal activity producing cylindrical pipes between the Upper Eocene and the Pliocene deposits, east of Helwan. Conglomeratic bands are recorded with dolerites and "Red Beds" at Tanka on the eastern coast of the Gulf of Suez.

The Miocene deposits are more widely spread than those of the Oligocene. They cover about 12 per cent of Egypt's surface. They are represented by different types of sediments. These are : (1) marin deposits showing local variations and comprising essentially sands, grits, marls, marly sands, limestones and gypsiferous clays occurring in the northern plateau of the Western Desert, as well as along the Cairo-Suez road in the northern stretch of the Eastern Desert ; (2) fluvio-marine sediments composed of sandstones, limestones and gypsiferous marls with marine invertebrates and land vertebrates and silicified woods, being similar to those of the Oligocene and the Upper Eocene.

Such sediments are present in the Moghra District (Western Desert) ; (3) saline deposits composed of anhydrite and gypsum existing in the Gulf of Suez area and in Northern Sinai, and (4) fresh water shelly chalks and sandy beds represented south of Siwa and north of the Galala El-Bahariya plateau.

It is worth mentioning that conglomeratic beds reaching 40 metres and composed of granitic boulders are found at the top of the Middle Miocene at Abu Shaar and Dishet El-Daba. Moreover, conglomerates occur in the early Middle Miocene at Ras Matarma and Sudr Oil Fields, but their exact age is still a matter of controversy. Towards the eastern border of the graben faults nearly all the members of the Miocene, on the eastern coast of the Gulf, seem to change laterally into gritty sandstones, clays and conglomerates (Tromp, 1951).

The Pliocene sediments are encountered in places in the Western Desert, the Nile Valey and along the coast of the Gulf of Suez and the western side of the Red Sea. The deposits of this period are mainly marine limestones and clays. In Wadi Natrun, however, estuarine sands and gypsiferous clays with land remains of fishes, reptilians and mammals are encountered. Near the Pyramids, the Lower Pliocene marine beds are separated from the Eocene by a conglomerate. Another conglomerate intervenes between the Upper Eocene and the Upper Pliocene marine calcareous deposits at Quait Bey (Farag, 1953). Early Pliocene terrestial conglomerates, gravels and sands occur in the Nile Valley south of Beni Suef. These are derived from sedimentary rocks of Cretaceous and Eocene age, with little or no crystalline rock pebbles. At the western coast of the Gulf of Suez the Pliocene deposits are mainly rock salt and diatomaceous earth.

It is evident, therefore, that the Tertiary rocks are, in general, different from those of both the Paleozoic and Mesozoic. They are characterised by the presence of (1) autochthonous limestones and orthoquartzitic sandstones and (2) conglomerates fluviatile deposits and basaltic flows. The former types indicate epirogenic conditions of sedimentation, whereas the latter are suggestive of development during relatively minor crustal disturbances. It is known that the Alpine orogeny took place during the Tertiary giving rise to the flysch (geosynclinal) sediments of the Alps. It would appear that Egypt was affected intermittently by pulses of this great diastrophic movement which was taking place at a relatively remote distance. The facies of sedimentation of the different Tertiary rocks bear witness to such pulses, which caused uplifts, faulting and basaltic flows. There are sediments (mainly conglomerates) and volcanic flows marking minor crustal disturbances in the following ages : Early Middle Eocene, late Middle Eocene, late Upper Eocene, Oligocene, late Oligocene-early Miocene, late Middle Miocene, late Miocene-early Pliocene and late Pliocene.

CONCLUSIONS

The Egyptian sediments are principally of three distinct types :

(1) The pre-Cambrian sediments are mainly slates, greywackes and conglomerates mixed with greenstones and tuffstones. They belong, therefore, to the geosynclinal facies of sedimentation. They mark the great orogenic movements which prevailed during this era.

(2) The Paleozoic and Mesozoic sediments are remarkably different from those of the pre-Cambrian. They are chiefly orthoquartzitic sandstones and autochthonous limestones belonging to the platform facies of sedimentation. They are suggestive of the relative stability, peneplanation, and slow erosion and deposition which took place during the different periods of both the Paleozoic and the Mesozoic.

The conglomerates which are encountered, in places, between the Cretaceous and Middle or Upper Eocene are indicative of local uplifts (the Syrian Arcs orogenic movement).

(3) The Tertiary sediments are a mixture of types which belong to the platform facies of sedimentation and of conglomerates, fluviatile and fluvio-marine deposits. Basaltic flows of late Oligocene age are encountered in different places. Such rocks are suggestive of intermittent slight crustal movements. These movements appear to be pulses of the great Alpine orogeny. The ages of these pulses are principally early Middle Eocene, late Middle Eocene, late Upper Eocene, Oligocene, late Oligocene-early Miocene, late Middle Miocene, late Miocene-early Pliocene and late Pliocene.

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NOTICE NECROLOGIQUE SUR LE PR. G. V. ANREP
(23 Septembre 1893 - 10 Janvier 1955)

par le

Prof. CH. AVIERINOS

Un grand physiologiste, un des plus hauts représentants de la Médecine Egyptienne, notre cher collègue, le Prof. Anrep, a succombé le 10 janvier 1955, alors que quelques mois avant sa mort il était encore sur la brèche, en plein travail scientifique. Né le 23 Septembre 1893 à Saint Petersburg, Anrep descendait d'une vieille famille de nobles, originaires de Riga. Il fit ses études médicales en Russie et les terminait en 1915, époque à iaquelle survint la grande tourmente. Anrep s'engagea alors dans l'armée Russe, et fut blessé deux fois, après avoir été au feu 17 fois.

Quelques années plus tard, en 1918, il obtint son doctorat en médecine et devint assistant de l'éminent professeur physiologiste Ivan Pavlov. Son maître exerça sur sa destinée médicale une influence décisive, et sous l'égide de ce savant, le défunt que nous commémorons aujourd'hui acquit les bases de la physiologie et prit le goût de la recherche médicale, qu'il sut, d'ailleurs, pousser si loin avec autant de mérite que de valeur.

Anrep quitta la Russie en 1920 et vint s'installer à Londres où il fut promu professeur agrégé de physiologie à l'Université de Londres, sous la direction du Pr. Starling. En 1925, il reçut le Doctorat ès sciences. Trois années plus tard il était élu membre de la Société Royale, juste récompense pour ses précieux travaux sur la cardiologie et la digestion.

Au cours de la même année, il était élu professeur agrégé de physiologie à l'Université de Cambridge, puis, en 1930, il arrivait au Caire pour être nommé, l'année suivante, Professeur titulaire de la chaire de physiologie à la Faculté de Médecine de Kasr-el-Aini (Université du Caire), succédant à notre collègue le Professeur Wilson ; il conservait ce poste jusqu'en 1952, date à laquelle atteint par la limite d'âge il était mis à la retraite.

Il gravit ainsi tous les échelons jusqu'aux plus hautes distinctions médicales et scientifiques. Jusqu'à sa retraite on le trouvait aussi alerte qu'à ses débuts. Jamais son zèle ne se ralentit pendant ces vingt deux années qu'il occupa la chaire de physiologie à la Faculté de Kasr el-Aini. Il conservait le même enthousiasme, et la même activité scientifique.

Dans cette tâche, il ne se contenta pas seulement de former, avec d'ailleurs un succès toujours croissant, plusieurs générations d'étudiants, mais il réunit autour de lui certains jeunes médecins, et créa entre eux une union scientifique, en les orientant vers la recherche expérimentale. Travailleur ardent, d'une activité débordante, possédant la bibliographie mondiale, dirigeant heureusement les recherches de son Laboratoire, il était un physiologiste d'une sûreté incomparable.

Il excellait dans les travaux de recherches qu'il présentait avec clarté et précision, réunissant autour de lui des collaborateurs qualifiés et dévoués.

Son travail obstiné, ses qualités morales et intellectuelles méritèrent à Anrep, une renommée mondiale, qui ne fut que la juste gloire et la récompense de sa brillante carrière. La renommée du grand défunt avait, depuis longtemps, dépassé les frontières de l'Egypte, si bien qu'il était devenu membre de plusieurs Sociétés savantes tant de l'Ancien que du Nouveau Monde.

Il a eu la satisfaction d'avoir formé pendant ces longues années de travail, d'excellents élèves, plusieurs desquels sont actuellement des maîtres dans notre science. Parmi eux, je citerais Blalock, qui professe avec éclat la chirurgie cardio-vasculaire à Baltimore et dont le nom, grâce à l'opération imaginée par lui et la Dr. Taussig est devenu célèbre universellement. Parmi eux encore, le Dr. Talaat du Caire, excellent physiologiste et Professeur à la Faculté de Médecine de Kasr-el-Aini, Downing, Hauesler, King, Stacey, Saalfeeld et bien d'autres encore, qui ont exécuté de remarquables travaux scientifiques.

L'œuvre scientifique d'Anrep est en réalité considérable et nombreux sont ses travaux qui lui acquirent une place prédominante dans le domaine de la physiologie. Plus de 90 publications en effet viennent confirmer son ardeur communicative au travail et son génie créateur.

Par ses travaux, il sut contrôler et discuter pertinemment les données classiques, enrichissant la physiologie contemporaine de nouvelles et originales conceptions.

Parmi les travaux physiologiques du Pr. Anrep, il convient de citer tout d'abord ses recherches sur la circulation coronarienne. Il poursuivit des travaux expérimentaux sur ce problème pendant dix années et il précise les règles qui régissent la circulation coronarienne. Il résulte de ces travaux importants que la systole ventriculaire constituerait un obstacle à la circulation coronaire, d'autant plus grand que la contraction cardiaque serait plus énergique. Ainsi, d'après Anrep et ses collaborateurs, le flux coronaire s'effectue-t-il sans résistance principalement pendant la révolution cardiaque, qui correspond à la diastole, dépendant ainsi de la pression moyenne systolique-diastolique de l'aorte.

Dans un autre groupe de travaux, il compléta les conclusions de son maître Pavlov sur la digestion.

Son œuvre était tellement diffusée et appréciée à l'étranger qu'il fut appelé, en 1935, par l'Université Stanhope de New York pour donner une série de conférences sur le système cardio-vasculaire, qui ont été publiées par la Société Harvey. Avant son départ des Etats Unis, on lui proposa la chaire de physiologie à l'Université Stanhope : il la refusa et retourna en Egypte.

Durant les dernières années de sa vie, il s'est occupé de la question, toujours aussi actuelle, de l'allergie. Son œuvre n'était cependant pas encore achevée ; il lui restait un dernier devoir à remplir ; celui-ci suprême : présider le Congrès International de physiologie de Londres du 15 Avril 1955, et communiquer les résultats de ses ultimes études sur l'allergie.

Il serait inutile de rappeler et d'analyser ici tous ses travaux scientifiques et les contributions capitales apportées encore par lui dans le domaine physiologique.

Un grand esprit et un grand cœur ont disparu : le Professeur G.V. Anrep n'est plus. Tous ceux qui l'ont connu dans l'éclat de son enseignement magistral comme dans l'intimité de son Laboratoire éprouveront certainement un profond serrement de cœur.

Elève de deux savants physiologistes réputés, Anrep, mérite vraiment à tous égards, par toutes ses qualités intellectuelles et

morales, la renommée mondiale pourtant si difficile à acquérir. Aussi, la postérité inscrira-t-elle dans son livre d'or le nom d'Anrep, comme celui d'un être d'élite, esclave du devoir, qui s'est donné, corps et âme, au culte de la science dont il était le noble et dévoué serviteur.

Le nom d'Anrep est un titre de gloire pour la Faculté de Médecine du Caire : il y laisse une superbe pléiade d'élèves ; ceux-ci diront mieux que moi, par leurs actes et leurs paroles, toutes les qualités du Savant et du Professeur.

Il m'avait honoré de son affection et de sa confiance scientifique, il me les a témoignées à maintes reprises de façon si touchante et si spontanée qu'aujourd'hui m'adressant à Mme Anrep et à son fils, je veux leur exprimer au nom de mes collègues et en mon propre nom nos respectueuses condoléances et l'assurance de notre vive sympathie dans leur grande douleur. Je dépose sur sa tombe l'hommage profondément ému de mon admiration.

List of Scientific Contributions made by and under the immediate direction of Dr. G.V. Anrep, Doctor of Medicine, Master of Arts, Doctor of Science, Fellow of the Royal Society, at present Professor of Physiology at the Faculty of Medicine, University of Cairo, Egypt.

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ANTHROPOMORPHIC AND ZOOMORPHIC LETTERS IN THE HISTORY OF ARABIC WRITING [1]

by

Dr ADOLF GROHMANN

It is now just 110 years since *Michelangelo Lanci* published the first samples of both kinds of these fancy forms of writing in his "Seconda opera Cufica, Trattato delle simboliche Rappresentanze Arabiche, Paris 1845-46 [2]. And although *Joseph von Karabacek* [3], the originator of scientific Arabic Paleography, has occasionally shown the interesting rôle, which these "Drôleries Arabes" played in art and in the history of script, nobody has yet consecrated special studies to it [4].

In my last lecture "The Origin and Early Development of Floriated Kufic" (on 25th April, 1955) I had already lightly touched upon these strange and fantastic products of the marvellous art of Arabic writing. I have tried to show, in what close connection with Hellenistic book-illumination the evolution of "Coufique fleuri" happened to be. Now the same can be stated concerning the group of "fancy letters," anthropomorphic as well as zoomorphic, the former using human bodies or parts thereof, the latter bodies of animals or parts thereof, as elements of Arabic script.

Kurt Weizmann [5], in a brilliant study on the Greek sources of Islamic scientific illustrations, has lately shown, how

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(1) Communication présentée en séance du 5 mars 1956.

(2) Trattato delle simboliche Rappresentanze Arabiche e della varia generazione de' musulmani caratteri sopra differenti materie operati (Paris 1845-1846) Pls. XXIX, XXX, XL - XLI, XLV, XLVI.

(3) Die persische Nadelmalerei Susandschird (Leipzig 1881), pp. 129, 130.

(4) Cf. N. *Kondakov*, **Zoomorphe Initialen in gricchischen** und glagolithischen Handschriften des 10. bis 11. Jahrhunderts in den Bibliotheken des Sinai (Petersburg 1905).

(5) Archaeologica Orientalia in memoriam *Ernst Herzfeld* ed. *G. C. Miles*, New York, 1952, pp. 244-266. especially p. 265.

strongly "Arab illustrators were exposed to Byzantine influences not only in the stage of the first reception from the Greek, but even long thereafter, since they adapt step by step the innovations which in the Greek manuscripts themselves developed only gradually." The present study may form a further contribution to the problem how far and in which way Arabic art preserved and developed the heritage of Hellenistic art.

Without going into further details I shall try to draw only a rough sketch of the evolution concerned here.

The decoration of letters with floral elements begins in the sphere of Greek and Latin writing as early as the third century A.D. (6) In the fourth century the vertical stroke of Jota is filled in with a herring-bone ornament in the codex of Virgilius Augusteus in Rome (7), in the sixth century A.D. the Orosius-codex in the Bibliotheca Laurentiana in Florence shows zigzag lines and the herring-bone ornament, and even a modest tendril as decoration of the initials (8) (Plate I, 1). In the seventh century A.D. the parchment psalter in the National Library in Paris (9) (Plate I, 2) shows a zigzag band, and in the eighth century A.D. a Greek lectionary (Plate I,3) in the Library of the Propaganda Fidei in Rome a letter Pi (π)with plaited band. (10)

Both motifs are very frequent in Coptic (Pl. I, 4) (11), Greek and Armenian initials in the following nineth, tenth and eleventh centuries (Pl. I, 5, 6) (12). But very early Greek book-

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(6) Cf. Martial xiii, 75, Ausonius. — *J. Strzygowski,* Byzantinische Denkmaeler I, p. 90.

(7) *C. Nordenfalk,* Before the Book of Durrow, Acta Archaeologica XVIII (1947), p. 152, fig. 9.

(8) Ibid., p. 152, fig. 10, 153, fig. 11, 154, fig. 13. For the Orosius-codex cf. also *C. Nordenfalk,* En senantik initialhandskrift,Kunsthistorik Tidskrift XVI (1937), pp. 117 ff.

(9) Codex Coislinianus No. 186, cf. *Stassoff,* L'Ornement Slave et Orientale, Pl. 120, No. 22.

(10) *Stassoff,* op. cit., Pl. 132, No. 17.

(11) Ibid., Pl. 132 No. 21, a Coptic Lectionary Ms. 32, eighth century A.D. in the Library of the Propaganda fidei in Rome.

(12) Cf. *Chaghbakeank',* Die fürstliche Familie der Chaghier oder Proschier, col. 170, fig. 70. *Garegin Howsapian,* Materialien und Studien zur Kunst- und Kulturgeschichte, fasc. A (Jerusalem 1935), p. 20, fig. 3. Plate I,5 is given after *H. Bordier,* Description des peintures et autres ornements contenus dans les manuscrits Grecs de la Bibliothèque Nationale (Paris 1885), p. 97, fig. 39 (Ms. grec 438), Plate I,6 after p. 117, fig. 55 (Ms. Grec 654, tenth century A.D.) of the same work.

illumination did not confine itself to mere floral or geometrical elements: the *human* figure as well as the figure of *animals* were included in the decoration of initials as early as the sixth century A.D. The first appearance of human figures is proved by the Book of Kells, which is dated in the sixth — from some scholars in the ninth — century A.D. (13), that of animals in a Latin Gospel manuscript in the National Library in Paris (Pl. I, 7) (14), where e.g. the right shaft of A is formed by a fish (seventh century A.D.), or in a manuscript of the eighth century A.D. in the library at Laon, where fishes form the initial Iota and a dragon's head the initial Sigma (S) (Pl. I, 8) (15)). To the same time belongs a Greek gospel manuscript in the National Library in Paris, in which e.g. the initial Alpha shows a dragon (Pl. I, 9) (16). This animal also forms an initial in the ninth century A.D. (17), and a bear with a snake occurs in the Beta (B) in a Greek gospel manuscript of the tenth century A.D. in the National Library in Paris (Pl. II, 1) (18).

Birds preferably are used for the composition of ingeniously designed initials, e.g. the initial L in a Bible of the tenth century A.D. formerly in the Abbey St. Martial de Limoges (19), or the codex Vaticanus Graecus No. 1162 of the eleventh century, where an Epsilon ϵ is compounded of a hawk and a falcon with a hare in the middle (20). In Armenian manuscripts, e.g. of the thirteenth, fourteenth centuries A.D. the whole alphabet is formed of such birds (Pl. II, 2) (21); it may go back here as far as even the ninth century A.D.(22). In the sphere of *Islamic art* the first attempts to combine letters with an anthropomorphic

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(13) Cf. *L. v. Kobell,* Kunstvolle Miniaturen und Initialen aus den Handschriften des 4.-16. Jahrhunderts (München 1890), p. 6.

(14) *Lecoy de la Marche* Les manuscripts et la miniature, (Paris s. a), p. 137, fig. 32 (Codex Latinus No. 256).

(15) Ibid., p. 139, fig. 33.

(16) *H. Bordier,* Description des peintures et autres ornements contenus dans les manuscrits Grecs de la Bibliothèque Nationale, p. 60, fig. 3 (Codex Grec No. 277).

(17) *Lecoy de la Marche,* op. cit., p. 141.

(18) *H. Bordier,* op. cit., p. 105, fig. 48 (Ms. grec No. 64, fol. 12).

(19) *N. Kondakoff,* Histoire de l'Art Byzantine (Paris, 1886), p. 27.

(20) *S. Beissel,* Vatikanische Miniaturen (Freiburg i/Br. 1893), Pl. XV.

(21) *J. Strzygowski,* Byzantinische Denkmaeler, I, p. 90. — Cf. *Chargh-bakeank',* op. cit. col. 234, fig. 102.

(22) *J. Strzygowski,* op. cit. I, p. 95.

or zoomorphic ingredient begins in the twelfth century A.D. The occasion thereto is offered by the knoblike top of Alif, already occurring in manuscripts of the eleventh century A.D. (Pl. II, 3) ([23]). On a bronze-kettle, dated 559 A.H. (1163 A.D.) in the Ermitage Museum in Leningrad, made in Herât ([24]), the top of Alif is transformed into a human head in the inscription of the first and fifth line (Pl. II, 4), and similar tops of Alif are to be seen on a bronze-ewer in the Gulistân Palace Museum in Teherân (twelfth century A.D., Pl. II, 5) ([25]), a candle-stick of bronze in the same Museum ([26]), on a brass-ewer in the British Museum (Pl. II, 6) in the first and last band of writing ([27]), a brass-ewer in the Musée du Louvre (twelfth/thirteenth century A.D., Pl. II, 7) ([28]), in the first and last bands of writing. In a brass-casket in the Victoria and Albert Museum, South Kensington, this form of the Alif is merely used as an ornament and shows no human face ([29]). It is by no means difficult to point to parallel ornaments in Greek illuminated manuscripts: e.g. Pl. II, 8 shows the initial in the Greek manuscript in the Bibliothèque Nationale in Paris of the tenth century, ending in two human heads ([30]). Anyhow, it needed two centuries, before this decoration found its way into the embellishment of Arabic letters, not only for the letters Alif and Lâm, but of other letters also. So the inscription on a golden vessel, originally in the possession of the Roman jeweller *Rota* ([31]), (Pl. II, 9), shows human heads at the top of all letters of the inscription

, باليمن والبركة والدولة والسرور والتامة والسعادة والعافية والعناية والقناعة والقادرة والقدرة والدولة لصاحبه

(23) E. g. PER Inv. Chart. Ar. 17631 (MPER IV, p. 80).

(24) *A. Pope*, A Survey of Persian Art, VI (1939), Pl. 1308.

(25) Ibid. Pl. 1314, Ars Islamica V/2, 1938, fig. 1 opposite p. 113.

(26) Ibid. Pl. 1316.

(27) Ibid. Pl. 1325.

(28) Ibid. Pl. 1328. Human heads turned *to the right* decorate the shafts of Alif and Lâm in the Naskhî inscription of a candlestick, published by *Bishr Faris*, Essai sur l'esprit de la décoration islamique (Conférences de l'Institut Français d'Archéologie Orientale, III. Cairo 1952) Pl. IV b and p. 29. It was made in Mosul about 1294 A.D.

(29) Ibid., Pl. 1359.

(30) *Lecroy de la Marche*, op. cit., fig. 95, p. 285.

(31) *M. Lanci*, Seconda opera cufica, vol. III, Pl. xxix, vol. II, p. 63.

and a gold-ewer and plate in the same collection ([32]), later belonging to the *Odiot*-collection in Paris, shows the same elaborate kind of writing. The ewer (Pl. III, 1) العز و الاقبال و الدولة و الراحة
the plate (Pl. III, 1) العز و البقا و المدحة و الثنا و الرفعة و العلا و العافية و السنا و البر
و العطا لصاحبه أبداً

A further example is offered by the goblet in the Museum in Bologna ([33]). Already in the thirteenth century A.D. animal heads are used in addition to human heads on a pen-case in the Freer Gallery of Art, Washington (Pl. III, 2) made by Shâkir, the engraver, in 607 A.H. (1210/11 A.D.) ([34]):

عمل شاكر النقاش فى شهور سنة سبع وستمائة
دوا(ة) لشاكر و الشاركة و النعمة و الرياضة

The *hastae* of Alif and Lâm end in human heads, but a goat's head forms the top of Kâf, and furthermore heads of a lion, a dragon, a dog adorn the tendril intersecting the letters, while in the upper inscription Râ, Yâ and Sîn end in bird-heads (Pl. III, 2). It, therefore, recalls the inscription on a seal of the sixth century A.H. (XIIth century A.D., Pl. IV, 1) ([35])

ذكر الله نور الايمان

where the Kâf in ذكر , Râ in نور and Nûn in الايمان end in bird-heads, while the other letters are richly decorated with floral elements, and on a textile from Palermo ([36]) of the twelfth century A.D., where the tops of Alif also end in bird-heads. We have already seen that the decoration with bird-heads is frequently used in Greek manuscripts of the tenth century A.D. and may, in Armenian manuscripts, go back even as far as the nineth century A.D.

The culminating point in the creation of zoomorphic and anthropomorphic letters is then reached in the course of the twelfth century A.D. in the well known bronze-vessel made at

(32) Ibid. op. cit., vol. III, Pl. xxx, vol. II, p. 64.

(33) Ibid., vol. III, Pl. XL, XLI.

(34) Ars Orientalis, I (1954), fig. 8, p. 27.

(35) *M. Lanci*, Seconda opera Cufica, vol. III, Pl. LXIII, 7; *J. von Karabacek*, Susandschird, p. 130.

(36) *F. Fischbach*, Ornamente der Gewebe (Hanau 1883), Pl. XIX.

Mosul in 629 A.H. (1232 A.D.) in the collection of the Duke of Blacas ([37]) (Pl. IV, 2), where the inscription الغبطة الدائمة consists of human and animal bodies.

A similar piece is known from the collection of Don Philipp Andrea Doria Pamphili Landi ([38]) with the inscription :

العز الدائم والاقبال الخالد والجد الزائد

It is important to state that in the Islamic sphere of art zoomorphic and anthropomorphic letters appear comparatively late, but early enough to be contemporary with Byzantine and Armenian manuscripts. The highest degree of perfection in the artistic decoration of the initials was reached by Irish monks, who greatly influenced the Carolingian revival of book-art. We know that they travelled as far as Egypt in the sixth century A.D., and they may have been able to see the marvellous production of Alexandrian book-art, of which almost nothing has remained. So their manuscripts of the eighth to the nineth centuries A.D., which have been connected with the popular art of the Celts and Teutons, may reflect some Oriental influence which is unfortunately not so tangible, as one would wish, for the lack of comparative material of this period. Possibly the Arabic pieces shown here form steps on the long road of crossing and intersecting influences originating from Greco-Roman and Oriental art, as does the colophon of the Haggadah of the fourteenth century A.D. ([39]), in which all Hebrew letters are composed of human bodies only.

(37) *M. Lanci*, op. cit., vol. III, Pl. XLIII., 1; *J. von Karabacek*, Susandschird, p. 129.

(38) *M. Lanci*, op. cit., vol. III, Pl. XLV, XLVI, 2.

(39) Cf. *S. Grayzel*, A history of the Jews (Philadelphia, 1948), fig. 41, p. 382.

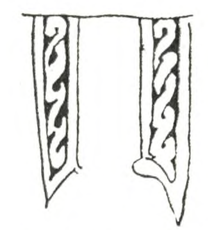
PLATE I



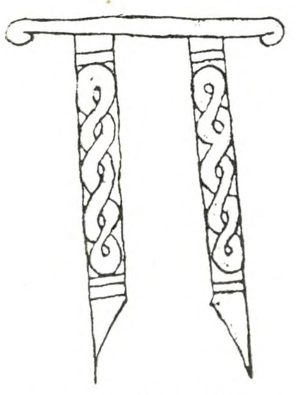
1. Orosius-Codex VIth cent. A.D.



2. Psalter (Paris) VIIth cent. A.D.



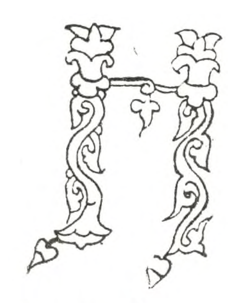
3. Lectionary. VIIth cent. A.D. (Rome)



4. Coptic Lectionary VIIIth cent. A.D. (Rome)



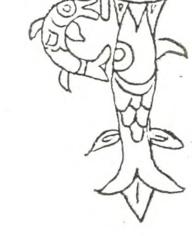
5. Greek Ms. 992 A.D. Paris



6. Greek Ms. Xth cent. A.D. (Paris)



7. Latin Gospels, Cod. lat. 256, Paris, Bibl. Nat. VIIth cent. A.D.



8. Initials from a Ms. in Laon, VIIIth cent. A.D.



9. Ms. Grec No. 277, VIIIth cent. A.D. (Paris).



1. Ms. Grec. No. 64, Bibl. Nat. Paris, Xth cent. A.D.



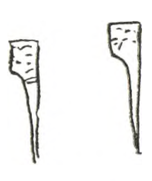
2. Armenian bird-initials (1375 A.D.)



3. Alif in PER Inv. Ar. 17631 (XIth cent. A.D.)



4. Bronze-Kettle in the Hermitage Museum (Leningrad) 1163 A.D.



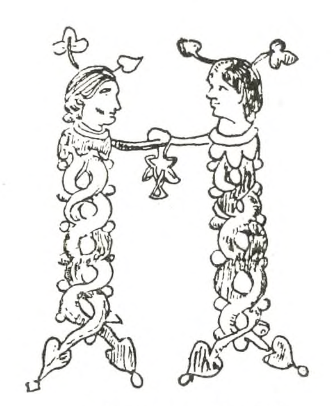
5. Bronze-ewer XII/XIIIth cent. A.D. (Teherân, Gulistan Palace Museum)



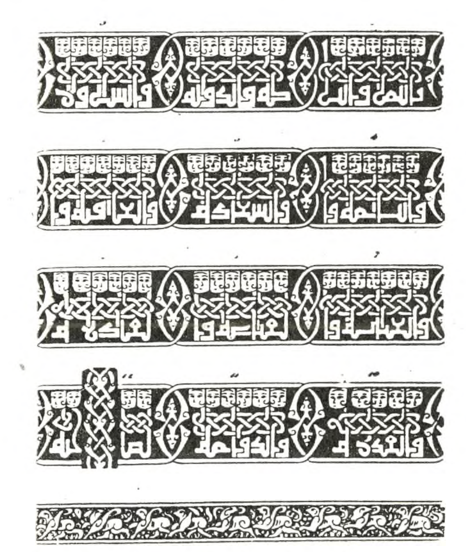
6. Bronze-ewer, British Museum XII/XIIIth cent. A.D.



7. Brass-ewer (Louvre) XII/XIIIth cent. A.D.



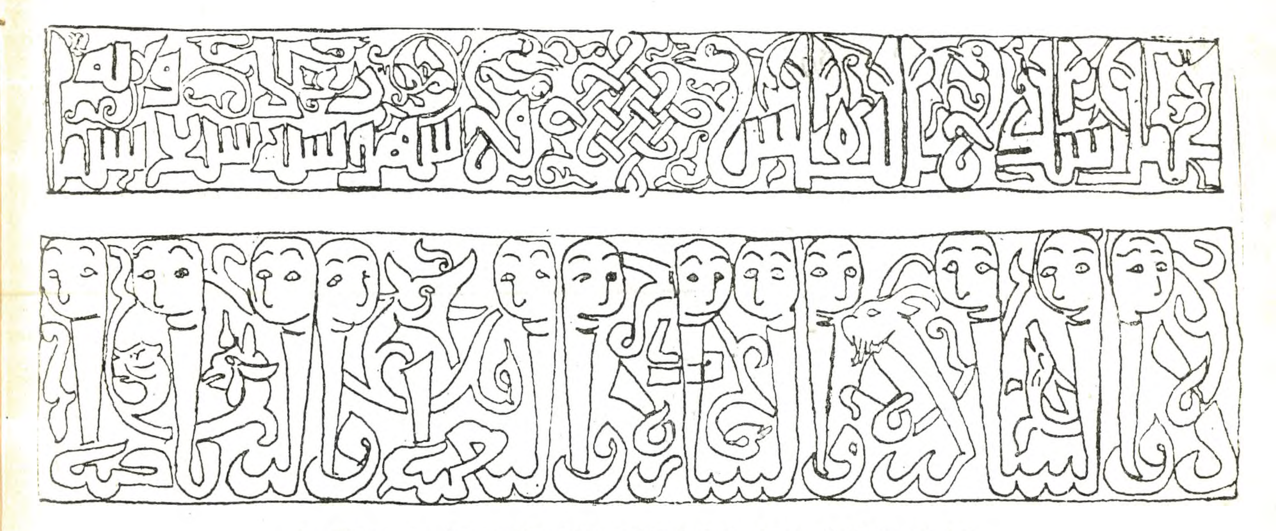
8. Greek Ms. 654 in the Bibliothèque Nationale, Paris, Xth cent. A.D.



9. Gold-vessel in the Rota-Collection.



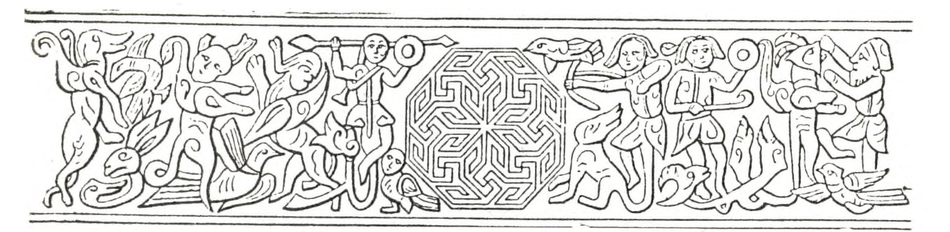
1. Above: gold-ewer in the Rota-Collection, below: gold plate in the same Collection.



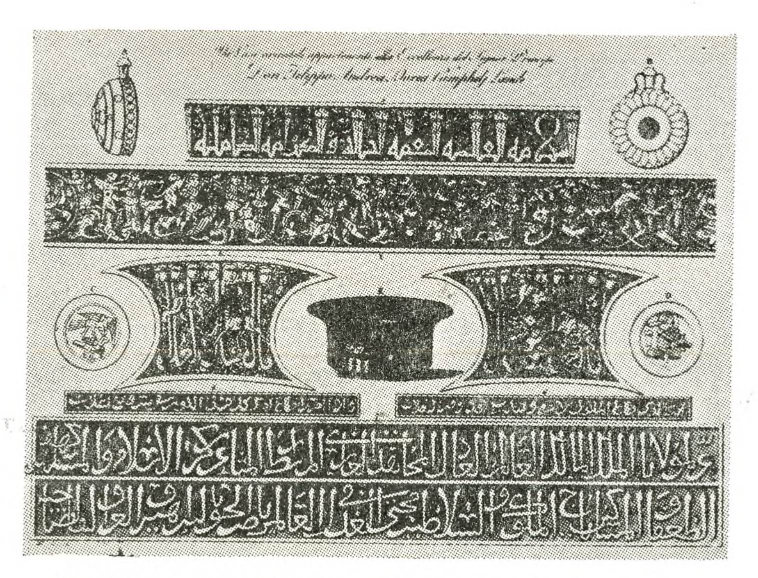
2. Pen-case, dated 607 A.H. (1210 A.D.), Freer Gallery of Art.

PLATE IV

1. Inscription on a seal, VIth cent. A.H. (XIIth cent. A.D.)



2. Bronze-vessel in the Collection of the Duc de Blacas.



3. Vessel in the Collection. Don Philipp Andrea Doria.

PHYSIOLOGICAL SIGNIFICANCE OF RESISTANCE AND SUSCEPTIBILITY — TO FUSARIUM WILT — OF SOME EGYPTIAN COTTON VARIETIES :

(III) Mycelial post-penetration fate and enzymic activity.

by

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1. INTRODUCTION

In two previous papers (Mostafa and Naïm 1954), the following aspects of physiological significance of resistance and susceptibility — between "Giza 26" and "Karnak" cotton varieties on one hand and *Fusarium solani* sensu Snyder and Hansen on the other hand — have been elucidated : (a) *Fusarium* mycelial and conidial development as influenced by cotton-seedling root metabolies; (b) Cotton-seedling vigour as influenced by rhizospheric *Fusarium* metabolites; and (c) Mode of fungal penetration in the two experimental cotton varieties. The present work has been subsequently carried out in an attempt to elucidate the following problems :

(i) The capacity of the fungus to invade the roots of the resistant "Karnak" cotton variety and its possible fate within its tissues.

(ii) Anatomical responses — to fungal invasion — in both resistant and susceptible cotton varieties.

(iii) *Fusarium* enzymic potentialities as influenced by the nature of the experimental cotton variety.

During the post-penetration phase of fungal invasion, the host plant may be induced to form cork layers impregnable to the mycelium. It has been suggested by Fahmy (1928) that the cork formation is responsible for the resistance of the Egyptian "Ashmouni" cotton variety to *Fusarium* wilt. Other examples

of resistance, due to cork formation, are manifested by flax (Tisdale 1917 resistant to *Fusarium lini* wilt and by cotton resistant to black root-rot due to *Thielaviopsis basicola* (Conant 1927). Varieties of potato resistant to scab (*Actinomyces scabies*) form cork more quickly, when wounded, than do susceptible varieties, and believed to owe their resistance to this characteristic (Jones 1931). Similarly, the ability to form a cork barrier is greater in varieties of narcissus resistant to basal rot, due to *Fusarium bulbigenum*, than in susceptible ones (Ghamrawy 1932). On the other hand, Thomas (1934) found that the newly-formed layer of cork cells was penetrated by invading hyphae of *Armillaria mellea* and that the cork layer did not successfully stop its advance. Brown (1936) stated that there is some doubt as to whether the cork layer really functions at all or whether it is formed after the fungus has been stopped by some mechanical means. Gum barrier, which cannot be permeated by the mycelium, has been also recorded to account for the recovery from a certain disease or to confer a type of resistance under certain seasonal conditions (Brooks and Co-workers 1923 - 1926). The gum barrier is formed by the reaction of the host plant; the result is the occultation of the invading fungal pathogen, which gradually dies out. Mostafa (1948) demonstrated the importance of gum-barrier formation within certain seasonal periods, as a response to invasion with one fungus and not with another, in competitive fungal parasitism.

The rôle of fungal enzyme (i.e. pectinase) in conferring resistance or rendering susceptibility to a certain host plant for a specific pathogen may manifest itself in two ways:

(i) Differences in the effect of the substrate on pectinase secretion (Vasudeva 1930, Horne 1930, Menon 1934 and Fernando 1937).

(ii) The activity of the enzyme as influenced by the conditions of the host cells (Klotz 1927 and Chona 1932).

The capacity of any particular pathogenic fungus to parasitize, and cause rotting of host tissues, was attributed to its ability to produce an active enzyme capable of macerating the middle lamellae of host cell-walls (De Bary 1886, Ward 1888 and Brown 1915). The enzyme, responsible for such type of maceration, was referred to as cytase (Brown 1917) and as protopectinase (Davison and Willaman 1927). In the present work, the initiation of the post-penetration phase is manifested by the traversing of *Fusarium* mycelium through cotton cortical cells until it becomes finally well established within the wood elements. During this initiation, *Fusarium* enzymic activity — as influenced by the nature of the experimental cotton variety — would be of primary importance.

2. FUNGAL POST-PENETRATION FATE

Seedlings, of either "Giza 26" or "Karnak" cotton variety, were raised on both sterilized and *Fusarium*-inoculated clay soil in the same method previously described (Mostafa and Naïm 1954). Roots, of raised seedlings of varying maturation, were fixed and embedded in paraffin in the usual way; microtome sections were made and double-stained with thionin and orange G (Stoughton 1930).

During the post-penetration phase, the fate of the invading mycelium differs according to the nature of the exeperimental cotton variety. In both cotton varieties, the fungal hyphae ramified inside the cortical cells. Inside "Karnak" cotton roots (Fig. 1 A), the fungal hyphae fade in the cortical tissues; they were never seen penetrating through endodermal cells and were completely absent from wood elements. On the other hand, in "Giza 26" infected roots, the fungal mycelium penetrated through the cortical cells and continued passing through the endodermal cells into wood elements and pith cells. It seems that the mechanical hinderance, rendered by thickened endodermal cells, stimulates the swelling of the fungal hyphal tips — in contact with their outer tangential walls — before penetration; minute hyphae, developed from these swellings, achieved actual penetration of endodermal cells (Fig. 1 B). The cortical cells, as well as pericycle, phloem parenchyma and xylem vessels, become impregnated with a deep brown gummy substance (Fig. 2); the latter was apparently pregnable for fungal hyphae. The walls of the vessels became discoloured and assumed a dark brown colour.

Karnak roots, cut off from infected raised seedlings, showed a very characteristic mechanical response — to cortical fungal invasion by formation of cork cells in the pericycle (Fig. 3). This pericyclic cork-cambial activity was clearly seen in a region lying slightly above the root-hair zone and higher up till the collar. This may play an important rôle in hindering the further mycelial advance into the vascular cylinder of "Karnak" roots;

the fungus was never observed in wood elements of these roots at different levels and at varying stages of seedling maturation.

3. FUNGAL ENZYMIC ACTIVITY

Fusarium enzymic activities have been tested — on different cotton extracts — as influenced by the variation of the following factors: (a) The nature of the experimental cotton variety; (b) The stage of cotton seedling naturation; (c) The type of sterilization treatment to which the original extract — on which *Fusarium* growth occurs — is subjected, whether it has been autoclaved or cold-sterilized; (d) The concentration of the original cotton extract upon which *Fusarium* metabolism takes place; (e) The PH variation due to previous *Fusarium* growth in the filtrate, and its possible effect on the fungal enzymic activity, has been eliminated by comparing the enzymic activity of such filtrate and on the same filtrate with its pH value restored to that of original extract; (f) The aging of the fungal filtrate, as determined by incubation period, on the resultant enzymic activity; and (g) *Fusarium* enzymic activities, at varying intervals, were also tested on a synthetic medium of known constitution (i.e. Dox's liquid) for comparison.

(i) Experimental Technique:

Aqueous cotton extracts were obtained from either two-weeks or four-weeks old "Giza 26" and "Karnak" whole seedlings as well as from roots of two-weeks old seedlings; autoclaved full-strength Dox's liquid was also prepared for comparison. The cotton extracts were obtained by weighing 100 grams of experimental seedlings or roots, cutting them into small pieces and washing with sterilized water for several times, and subsequently pounded for a period of five minutes — at full speed — in an electric grinding machine. The pounded extract was treated with sterilized water, filtered off, and the residue was washed — with water — for several times. The filtrate, as well as the aqueous solution resulting from washing the residue, were completed to one litre; this is considered to be 10% concentration and 5% was also prepared by its dilution. For each treatment and concentration, the extract was divided into two lots: one lot was autoclaved and the other was cold-sterilized by Menon's technique (Menon 1934). The latter involves the transference of the extract, into an ice chest for 24 hours, heated for ten minutes at 60°C, and then rapidly transferred again to the ice chest; the whole process has to be repeated for three consecutive times.

A standardized mycelial disc, from the edge of four-days old *Fusarium* culture, was cut and transferred into 25 c.c. of the experimental cotton extract and incubated at 30°C. A sample flask was chosen after the elapse of either one of the following incubation intervals: 2, 4, 7, 14 and 21 days. After the elapse of each experimental incubation period, the final pH value of *Fusarium* filtrate was determined colourimetrically; each filtrate was then divided into two portions: one portion was kept with its pH unchanged and the pH value of the other was restored to that of the original unconsumed extract. The enzymic activities, of the differently-treated *Fusarium* filtrates, were determined by Brown's disc method. This involves the determination of the average time required to achieve complete maceration of three potato discs of a known standardized size (i.e. 0.5 × 18.0 mms.). The time required for complete maceration is known as the reaction time (R.T.), and the enzymic activity — of the tested fungal filtrate — is expressed as the inverse reaction time multiplied by 100 (i.e. $\frac{1}{R.T} \times 100$). All the tested potato discs were cut, at the same time, from the medullary tissues of the same tuber. The enzymic activity — for each particular filtrate — was tested at its final and restored pH values. Controls were also used, where the potato discs were put in the original cotton extracts and in sterilized distilled water for comparison. In order to avoid bacterial contamination — through a period of 24 hours — two drops of toluene were added for every particular treatment.

(ii) Experimental Results:

A comparison on different treatment and concentrations of cotton extracts and on Dox's liquid, has been dealt with according to the following sequence of *Fusarium* enzymic activities on: (a) Two-weeks old seedling extract, (b) Four-weeks old seedling extract, (c) Root extracts from two-weeks old cotton seedlings, and (d) Dox's liquid. An attempt has been also made to interrelate the effects of these various experimental factors upon the resultant *Fusarium* enzymic activities.

(a) Two-weeks Old Seedling Extract.

The production of macerating exo-enzymes, by *Fusarium*, is very feeble under all experimental conditions. Enzymic activities (Table 1) could be only demonstrated in filtrates of comparatively younger ages (i.e. up to seven-days old), and they are of very low values. On two- or three-weeks old filtrates the reaction times exceed, however 24 hours in all treatments and concentrations of original cotton extracts, this means zero enzymic activity. The fungal growth results always in an increase in the pH value (Table II) ; on two- and three-weeks old *Fusarium* filtrates, from the two experimental concentrations of "Giza 26" and "Karnak" two-weeks old whole seedlings extracts, the pH values become highly alkaline (i.e. 8.5 or more). The complete degradation of *Fusarium* exo-enzymic activity in filtrates of comparatively older ages could not be correlated with the resulting high alkalinity, since the restoration of the pH values of such filtrates — to those of original corresponding extracts — fails completely to reactivate such degraded exo-enzymes. It is quite possible that the increased aging of filtrate is associated with a certain type of fungal metabolic potentiality inhibitory — in some way or another — for *Fusarium* exo-enzymic production or activity.

The resultant *Fusarium* exo-enzymic activity, in filtrates of comparatively younger ages, is found to be the output of the interaction of the following experimental factors :

(1) Type and treatment of original extract, whether cold-sterilized or autoclaved.

(2) Age of fungal filtrate.

(3) Concentration of original cotton extract on which *Fusarium* metabolism occurs.

(4) pH of filtrate, whether left unchanged or restored to that of original extract.

(5) Cotton variety from which the original extract has been obtained.

On the whole, *Fusarium* exo-enzymic activity is comparatively slightly greater on two-days old filtrates from "Giza 26" than from "Karnak" metabolized cold-sterilized extracts. The difference becomes, however, gradually eliminated with increased

TABLE I

Fusarium enzymic activity, after varying periods of time, on cold-sterilized (M) and on autoclaved (A) 5% or 10% aqueous extracts from two-weeks old "Giza 26" (G) and "Karnak" (K) cotton whole seedlings; the enzymic activity is considered zero when the reaction time exceeds 24 hours (< 24).

Extract conc.	* Time in days	Cotton variety	Treatment	pH value		Reaction time		Enzymic activity	
				Original	Final	pH (unchanged)	pH (restored)	pH (unchanged)	pH (restored)
5 %	2	(G)	(M)	6.7	7.4	16	18	6.3	5.6
			(A)	7.0	7.4	22	<24	4.5	—
		(K)	(M)	7.0	7.4	18	20	5.6	5.0
			(A)	7.6	7.9	<24	<24	—	—
	4	(G)	(M)	6.7	7.6	17	17	5.9	5.9
			(A)	7.0	7.6	24	<24	4.2	—
		(K)	(M)	7.0	7.6	18	22	5.6	4.5
			(A)	6.7	7.9	<24	<24	—	—
	7	(G)	(M)	6.7	7.9	22	22	4.5	—
			(A)	7.0	7.9	<24	<24	—	—
		(K)	(M)	7.0	7.6	22	<24	4.5	—
			(A)	6.7	8.5	<24	<24	—	-
10 %	2	(G)	(M)	6.4	7.6	16	<24	6.3	—
			(A)	7.0	7.4	20	<24	5.0	—
		(K)	(M)	7.0	7.4	18	20	5.6	5.0
			(A)	7.9	8.1	<24	<24	—	—
	4	(G)	(M)	6.4	7.6	17	<24	5.9	—
			(A)	7.0	7.6	22	<24	4.5	—
		(K)	(M)	7.0	7.6	17	22	5.9	4.5
			(A)	7.9	8.5	<24	<24	—	—
	7	(G)	(M)	6.4	7.9	21	<24	4.8	—
			(A)	7.0	7.9	<24	<24	—	—
		(K)	(M)	7.0	7.6	21	<24	4.8	—
			(A)	7.9	8.5	<24	<24	—	—

(*) After 14 and 21 days, enzymic activity is zero.

TABLE II

pH variations induced by *Fusarium* growth, on either 5% or 10% extracts from two-weeks old seedlings of "Giza 26" (G) and "Karnak" (K) cotton varieties after varying periods of time; the original extract is either cold-sterilized or autoclaved.

Extract conc.	Time in days	Cotton variety	Extract treatment (Cold-sterilized) pH (Original)	pH (Final)	(Autoclaved) pH (Original)	pH (Final)
5%	2	(G)	6.7	7.4	7.0	7.4
		(K)	7.0	7.4	7.6	7.9
	4	(G)	6.7	7.6	7.0	7.6
		(K)	7.0	7.6	7.6	7.9
	7	(G)	6.7	7.9	7.0	7.9
		(K)	7.0	7.6	7.6	8.5
	14	(G)	6.7	8.5	7.0	8.5
		(K)	7.0	8.5	7.6	8.8
	21	(G)	6.7	8.5	7.0	8.5
		(K)	7.0	8.5	7.6	8.8
10%	2	(G)	6.4	.6	7.0	7.4
		(K)	7.0	7.4	7.9	8.1
	4	(G)	6.4	7.6	7.0	7.6
		(K)	7.0	7.6	7.9	8.5
	7	(G)	6.4	7.9	7.0	7.9
		(K)	7.0	7.6	7.9	8.5
	14	(G)	6.4	8.5	7.0	8.5
		(K)	7.0	8.5	7.9	8.3
	21	(G)	6.4	8.5	7.0	8.5
		(K)	7.0	8.5	7.9	8.8

aging of filtrates of the two types of cotton extract. Autoclaving of original cotton extracts seems to induce an earlier or complete degradation of *Fusarium* exo-enzymic activity in comparison with that on corresponding cold-sterilized extracts; the relative occurrence of such complete degradation would depend upon the experimental cotton variety from which the original extracts have been obtained. Thus, autoclaving of original "Karnak" seedling extracts results in a complete degradation of the resulting *Fusarium* exo-enzymic activity, in comparison with its relative feebleness in filtrates from originally cold-sterilized extracts, at a very early stage of filtrate incubation and on filtrates obtained from the two experimental concentrations. On the other hand, complete *Fusarium* exo-enzymic degradation — on "Giza 26" autoclaved extract — takes place in filtrates of a comparatively older age (i.e. seven-days old); two- and four-days old pH-unchanged filtrates, from originally-autoclaved "Giza 26" seedling extracts, show comparatively weeker exo-enzymic activities than corresponding filtrates from cold-sterilized extracts. Autoclaving may result in either destroying certain extract constituents essential for *Fusarium* exo-enzymic activity or changing the original extract constitution in such a way that the resulting fungal metabolitic activity is suppressive for exo-enzymic production. Concerning age of filtrate, in cases where exo-enzymic activities are manifested, successive increase in age is generally associated with gradual decrease in enzymic activity.

With regard to pH factor, it manifests its effect in the two following aspects:

(a) The pH change, in filtrates of varying ages, and its possible effect on *Fusarium* exo-enzymic activity.

(b) The exo-enzymic activity as influenced by the restoration or non-restoration of the pH value of the same filtrates.

The relative enzymatic activities, as influenced by pH shifts due to successive aging of the same filtrate, have been already dealt with. On the other hand, restoration of pH values of filtrates — to those of original extracts — results usually in either partial or complete degradation of exo-enzymic activities. This might indicate that *Fusarium* exo-enzymic activity increases with increasing pH of filtrate due to previous fungal growth on original cotton extract.

The variation in the concentration of original extracts, from which fungal filtrates are subsequently obtained, does not appreciably influence the resulting *Fusarium* exo-enzymic activities in pH-unchanged filtrates from extracts of both cotton varieties as well as in pH-restored filtrates from "Karnak" extract. On the other hand, the restoration of pH values of filtrates — obtained from cold sterilized "Giza 26" extracts — results, on increasing the extract concentration, in causing an earlier degradation of exo-enzymic activity (i.e. complete degradation starts to occur in two days old filtrates at 10% concentration of original extract). This might be due to the possible presence of deactivating factor, which exerts more accumulative effect with increased concentration of the cold-sterilized "Giza 26" extract at restored pH.

(b) Four-weeks Old Seedling Extract.

Fusarium exo-enzymic activity is found to be completely degraded on all filtrates obtained from differently-treated extracts of four-weeks old "Giza 26" and "Karnak" cotton seedling. On comparing the pH values of cotton extracts from four-weeks old seedlings (Table III) with those obtained from two-weeks old seedlings (Table II), the former are found to be comparatively more acidic. Accordingly, *Fusarium* metabolism on four-weeks old seedling extracts results generally in producing filtrates of lower pH values than corresponding filtrates from two-weeks old seedling extracts. The complete degradation of *Fusarium* exo-enzymic activity at varying final pH values of filtrates, some of which approach those of active filtrates from two-weeks extracts, might indicate that the pH variations are not the primary cause. It may be, however, explained on the ground of either a change of host metabolism — as manifested by extract constitution — or more accumulation of a factor deactivating for enzymatic activity with increased maturation of seedlings of both the two experimental cotton varieties.

(c) Root Extracts from Two Weeks Old Cotton Seedlings.

On two-days old filtrate, from originally cold-sterilized root extracts, *Fusarium* exo-enzymic activity is slightly greater in "Giza 26" than in "Karnak". On the whole, the fungal enzymic activity is only demonstrated in comparatively younger filtrates obtained from cold-sterilized root extracts of both cotton varieties

TABLE III

pH variations induced by *Fusarium* growth, on either 5% or 10% extracts from four-weeks old seedlings of "Giza 26" (G) and "Karnak" (K) cotton varieties after varying periods of time; the original extract is either cold-sterilized or autoclaved. In all cases, the enzymic activity is considered to be zero.

Extract conc.	Time in days	Cotton variety	Extract treatment (Cold sterilized) pH (Original)	(Cold sterilized) pH (Final)	(Autoclaved) pH (Original)	(Autoclaved) pH (Final)
5%	2	(G) (K)	5.2 5.4	5.6 5.8	6.4 6.7	6.7 6.9
	4	(G) (K)	5.2 5.4	6.4 6.4	6.4 6.7	6.7 6.9
	7	(G) (K)	5.2 5.4	6.7 6.7	5.4 6.7	7.4 7.4
	14	(G) (K)	5.2 5.4	7.6 7.9	6.4 6.7	7.9 7.9
	21	(G) (K)	5.2 5.4	8.5 8.5	6.4 6.7	8.5 8.5
10%	2	(G) (K)	5.4 5.6	5.8 5.8	6.7 7.0	6.9 7.4
	4	(G) (K)	5.4 5.6	6.4 6.4	6.7 7.0	6.9 7.4
	7	(G) (K)	5.4 5.6	6.7 6.7	6.7 7.0	7.6 7.6
	14	(G) (K)	5.4 5.6	7.6 7.9	6.7 7.0	7.9 7.9
	21	(G) (K)	5.4 5.6	8.5 8.5	6.7 7.0	8.5 8.5

(Table IV); it acquires its maximal value in two-days old filtrates and becomes successively decreased with increasing age of filtrate up to seven-days old, above which it becomes completely degraded (i.e. in two-weeks and three-weeks old filtrates). Filtrates, of similar age and from originally cold-sterilized root extracts, generally manifest the same value of exo-enzymic activity quite independent of :

(a) pH value of filtrate (i.e. whether left unchanged or restored to that of original extract).

(b) Variation in experimental concentrations of original extract (i.e. 5% or 10%).

Fusarium filtrates, of varying ages and obtained from originally autoclaved root extracts of both cotton varieties, are proved to be exo-enzymically inactive. Autoclaving of original root extracts results always in shifting the pH values towards high alkalinity (Table V), which might indicate that autoclaving results in inducing a change in the constitution of the original extract. Accordingly, the failure of *Fusarium* to express any exo-enzymic activity on autoclaved root extracts may be due to either one or more of the following possibilities : (a) The change in the constitution of the original extract, through autoclaving, results in establishing a nutritive condition suppressive for the production of macerating exo-enzymes, (b) The modification in the constitution of the original root extract, induced by autoclaving, results in changing the subsequent *Fusarium* metabolic potentiality in such a way as to interfere with either the formation or activity of the fungal exo-enzymes through the production of a deactivating substance, and (c) High alkalinity of root extract, induced by autoclaving, interferes with *Fusarium* exo-enzymic activity or production.

(d) Dox's Liquid

Fusarium exo-enzymic activity on a synthetic medium of a known constitution "i.e. Dox's liquid" is found also to be very feeble (Table VI). It similitudes that on cotton extracts so far as the following points are concerned :

(1) *Fusarium* exo-enzymic activity, on pH-unchanged filtrates, decreases successively with increased aging of filtrate; three-weeks old filtrates express practically no nzymic activity.

TABLE IV

Fusarium enzymic activity, after varying periods of time, on cold-sterilized (M) and on autoclaved (A) 5% and 10% aqueous extracts from roots of two-weeks old "Giza 26" (G) and "Karnak" (K) cotton seedlings ; the enzymic activity is considered zero when the reaction time exceeds 24 hours (< 24).

Root extract conc.	(*) Time in days	Cotton variety		pH value		Reaction time		Enzymic activity	
				Orignal	Final	pH (unchanged)	pH (restored)	pH (restored)	pH (restored)
5%	2	(G)	(M)	6.7	7.4	16	16	6.3	6.3
			(A)	8.8	8.8	<24	<42	—	—
		(K)	(M)	7.0	7.4	18	18	5.6	5.6
			(A)	8.8	8.8	<24	<24	—	—
	4	(G)	(M)	6.7	7.6	18	18	5.6	5.6
			(A)	8.8	8.5	<24	<24	—	—
		(K)	(M)	7.0	7.6	18	<24	5.6	5.6
			(A)	8.8	8.8	<24	<24	—	—
	7	(G)	(M)	6.7	7.9	22	<24	4.5	—
			(A)	8.8	8.5	<24	<24	—	—
		(K)	(M)	7.0	7.9	22	<24	4.5	—
			(A)	8.8	8.8	<24	<24	—	—
10 %	2	(G)	(M)	6.4	6.7	16	16	6.3	6.3
			(A)	9.1	8.8	<24	<24	—	—
		(K)	(M)	7.0	7.4	18	18	5.6	5.6
			(A)	9.1	8.8	<24	<24	—	—
	4	(G)	(M)	6.4	7.4	18	18	5.6	5.6
			(A)	9.1	8.5	<24	<24	—	—
		(K)	(M)	7.0	7.6	18	18	5.6	5.6
			(A)	9.1	8.8	<24	<24	—	—
	7	(G)	(M)	6.4	7.9	20	<24	5.0	—
			(A)	9.1	8.8	<24	<24	—	—
		(K)	(M)	7.0	7.9	22	<24	4.5	—
			(A)	9.1	8.8	<24	<24	—	—

(*) After 14 and 21 days, enzymic activity is zero.

TABLE V

pH variations induced by *Fusarian* growth, on either 5% or 10% extracts from roots of two-weeks old seedlings of "Giza 26" (G) and "Karnak" (K) cotton varieties, after varying periods of time; the original extract is either cold-sterilized or autoclaved.

Extract conc.	Time in days	Cotton variety	Extract treatment (Cold-sterilized) pH (Original)	Extract treatment (Cold-sterilized) pH (Final)	Extract treatment (Autoclaved) pH (Original)	Extract treatment (Autoclaved) pH (Final)
5 %	2	(G)	6.7	7.4	8.8	88.
		(K)	7.0	7.4	8.8	88.
	4	(G)	6.7	7.6	8.8	8.5
		(K)	7.0	7.6	8.8	8.8
	7	(G)	6.7	7.9	8.8	8.5
		(K)	7.0	7.9	8.8	8.8
	14	(G)	6.7	8.5	3.8	8.8
		(K)	7.0	8.5	8.8	8.8
	21	(G)	6.7	8.5	8.8	8.8
		(K)	7.0	8.8	8.8	8.8
10 %	2	(G)	6.4	6.7	9.1	8.8
		(K)	7.0	7.4	9.1	8.8
	4	(G)	6.4	7.4	9.1	8.5
		(K)	7.0	7.6	9.1	8.8
	7	(G)	6.4	7.9	9.1	8.8
		(K)	7.0	7.9	9.1	8.8
	14	(G)	6.4	8.5	9.1	8.8
		(K)	7.4	8.6	9.1	8.8
	21	(G)	6.4	8.5	9.1	8.8
		(K)	7.0	8.8	9.1	8.8

(2) As in case of cotton extracts, *Fusarium* growth on Dox's liquid causes an increase in the pH value of the resulting filtrate. The restoration of pH values of fungal filtrates, to those of original unconsumed medium, does not affect exo-enzymic activity in filtrates of comparatively younger ages (i.e. two- and four-days old). On the other hand, in filtrates of advanced ages i.e. seven-days and more), restoration of pH values of filtrates results in complete deactivation of *Fusarium* exo-enzymic activity.

4. DISCUSSION

The present work deals with the post-penetration phase, with regard to the host-parasite relationship between "Giza 26" and "Karnak" cotton varieties on one hand and the wilt-inducing

TABLE VI

Fusarium enzymic activity, after varying periods of time, on a full strength of autoclaved Dox's liquid; the enzymic activity is considered zero when the reaction time exceeds 24 hours (< 24).

Time in days	pH value Original	pH value Final	Reaction time pH (unchanged)	Reaction time pH (restored)	Enzymic activity pH (unchanged)	Enzymic activity pH (restored)
2	5.4	6.4	18	18	5.6	5.6
4	5.4	6.7	18	18	5.6	5.6
7	5.4	7.3	20	<24	5.0	0
14	5.4	8.5	22	<24	4.5	0
21	5.4	8.8	<24	<24	0	0

Fusarium on the other hand, so far the two following aspects are concerned: (a) Mycelial fate within root tissues, and (b) *Fusarium* exo-enzymic activity. Concerning the first aspect, there is a prominent difference in the final fate of the fungal mycelium compared within the root tissues of the two experimental cotton varieties. Thus, within "Karnak" root cortical cells, the penetrating hyphae fade gradually in the cortical tissues; no trace could be detected within root vascular cylinder. On the other hand, in case of the susceptible "Giza 26" cotton variety, the fungal mycelium could establish itself successfully throughout the different root tissues including both vascular cylinder and pith cells. Parallel results were also obtained by Yablokova (1937) in her studies of the fate of *Fusarium buharium* in two cotton varieties, one of which was resistant and the other was susceptible. In addition, fungal presence in "Karnak" root cortical cells stimulates pericyclic cells for cambial activity and production of cork-barrier; similar mechanical responses, due to *Fusarium* invasion, were also recorded by other investigators (Tisdale 1917, Fahmy 1928, and Ghamraway 1932).

Concerning *Fusarium* enzymic activities, so far as the macerating exo-enzymes are concerned, the fungus was found to be of the dry-rot type; no significant differences could be detected in comparing the fungal exo-enzymic activities on extracts from "Giza 26" cotton variety on one hand and on those of "Karnak" on the other hand. On the whole, feeble macerating exo-enzymes could be only demonstrated in fungal filtrates, of comparatively younger ages, from extracts of "Giza 26" and "Karnak" two-weeks old seedlings and from their respective roots. The relative *Fusarium* exo-enzymic activities were found, however, to differ according to the variation of the following factors: (a) Maturation stage of cotton seedlings from which original extracts have been obtained, (b) Type of sterilization-treatment of original cotton extract, and (c) Aging of fungal filtrate. In addition, pH variations of filtrates and different concentrations of original extract may also play a certain rôle in influencing the resultant exo-enzymic activity.

Accordingly, the fading of the fungal mycelium within "Karnak" root cortical cells — and its free advance into different root tissues of "Giza 26" cotton variety — could not be attributed either to pH variation as to *Fusarium* exo-enzymic activities as influenced by the nature of the host variety. It may be, however, correlated with either one or more of the following responses: (a) Mechanical response by cork-barrier formation, (b) Nutritive constitution of root juices and extracts, and the possible presence of an inhibitory factor for either conidial germination or mycelial growth, and (c) The possible fungal metabolitic potentiality in producing factors either suppressive or stimulating for its own further mycelial growth. The first response has been already demonstrated in the resistant "Karnak" cotton variety; the possible rôles played by the two last responses will constitute, however, the subject matters of subsequent papers.

5. SUMMARY

1. The host-parasite relationship was elucidated, during the post-penetration phase, in relation to the two following problems: (a) Mycelial fate, and (b) *Fusarium* exo-enzymic activities.
2. The post-penetrated mycelium fades in the cortex of "Karnak" roots, while it continues to advance and penetrates through endodermal cells into vascular cylinder and pith cells of "Giza 26" cotton variety.
3. The most prominent anatomical response — to fungal invasion — is expressed by the resistant "Karnak" roots. Cork cambial activity is stimulated in pericycle; it occurs at a level higher than the root hair zone and reaches up to the collar. On the other hand, no such cambial activity is observed in invaded "Giza 26" roots.
4. Concerning *Fusarium* exo-enzymic activities in filtrates from either "Giza 26" or "Karnak" extracts, differences were found to be rather insignificant; the fungus, in both cases, produces feeble macerating exo-enzymes.
5. Exo-enzymic activity may vary, however, according to the interaction of the following factors: (1) Maturation stage of cotton seedlings from which extracts are obtained, (ii) Extract concentration; (iii) Extract sterilization-treatment; (iv) Age of filtrate, and (v) pH variation of fungal filtrate.

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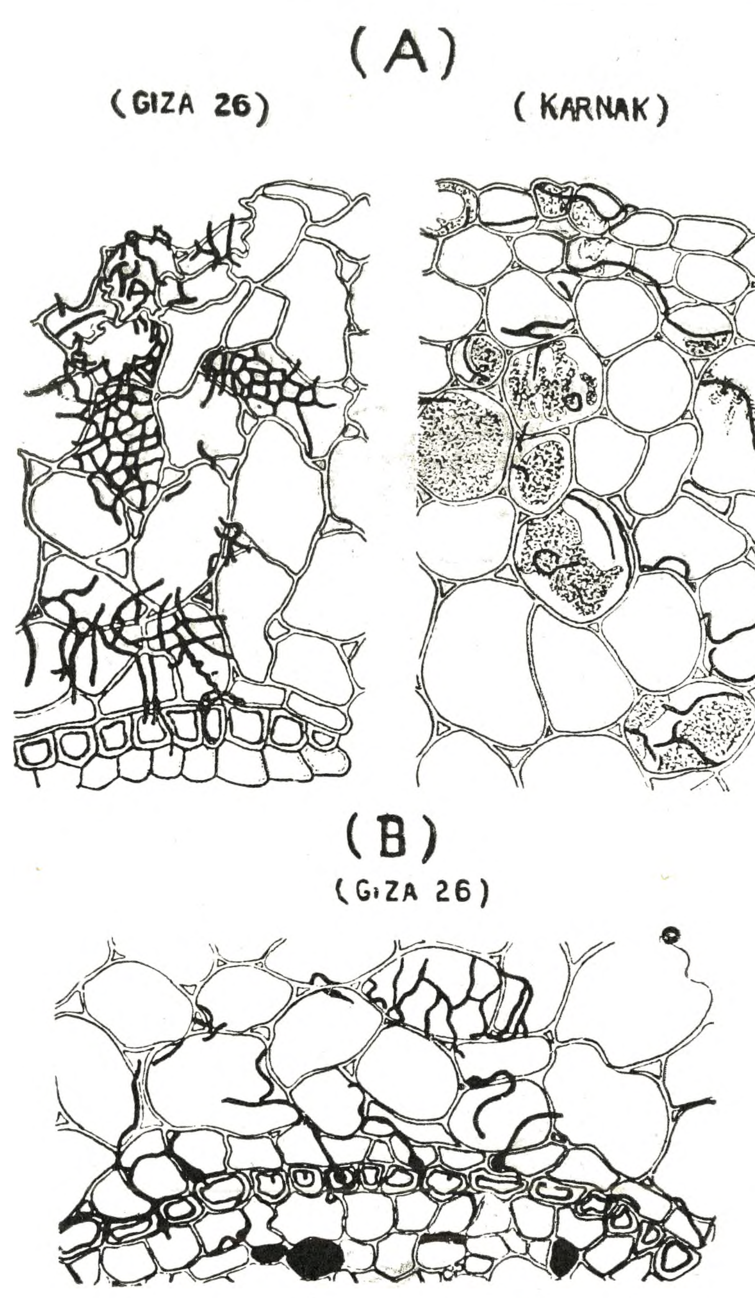


Fig. 1. — The relative distribution of *Fusarium* hyphae, during post-penetration phase, compared within "Giza 26" and "Karnak" cotton roots of two-weeks old seedlings (A); the penetration of endodermal cells of "Giza 26" roots is also shown (B). "× 480."

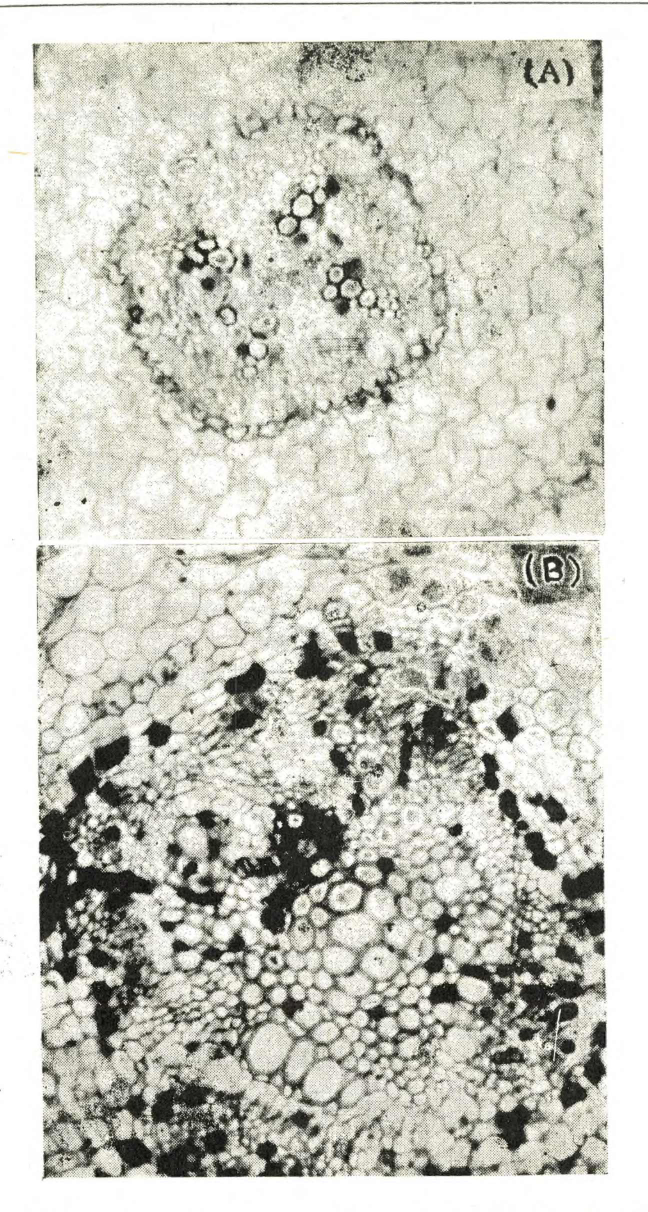


Fig. 2. — Microphotographs of transverse sections of "Giza 26" roots from healthy (A) "× 180" and from infected two-weeks old seedlings (B). "× 200."

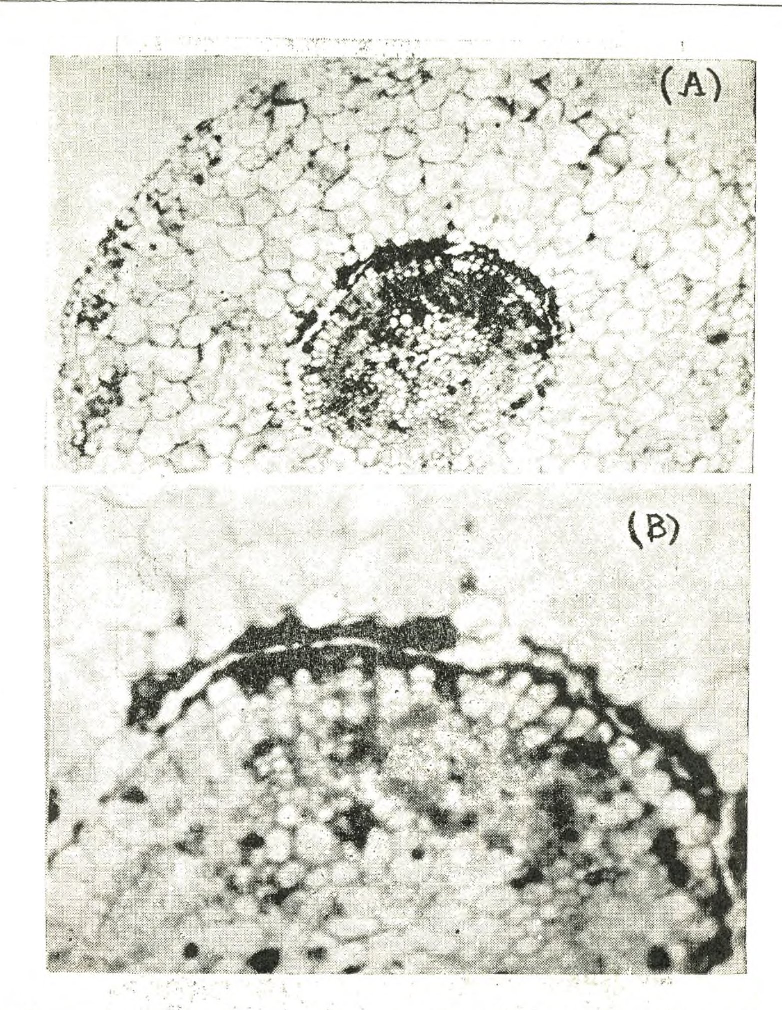


Fig. 3. — A microphotograph (A) "X 40" of infected roots of two-weeks old "Karnak" seedlings showing the mechanical response by formation of pericyclic periderm; the pericyclic region is enlarged in (B). "X 120."

PHYSIOLOGICAL SIGNIFICANCE OF RESISTANCE AND SUSCEPTIBILITY — TO FUSARIUM WILT — OF SOME EGYPTIAN COTTON VARIETIES :

(IV) Effect of seedling extracts — as influenced by cotton variety — on Fusarium mycelial growth and conidial germination.

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1. INTRODUCTION

In previous papers (Mostafa and Naïm 1954), the following problems have been elucidated with regard to the physiological significance of resistance and susceptibility between "Karnak" and "Giza 26" cotton varieties and *Fusarium solani* Sensu Snyder and Hansen:

(a) Pre-penetration phase concerning the effect of cotton-root metabolites on *Fusarium* mycelial growth and conidial germination on one hand and the effect of rhizospheric fungal metabolites on cotton-seedling vigour on the other hand.

(b) Penetration phase compared in the two experimental cotton varieties.

(c) Mycelial post-penetration fate so far as anatomical responses are concerned, as well as fungal macerating exo-enzymic activity, as influenced by the nature of the cotton variety.

The present work includes a study of another aspect of post-penetration phase concerning the effect of extracts from seeds, or from various parts of either "Giza 26" or "Karnak" seedlings of different maturation stages, on both *Fusarium* growth and conidial germination. Extracts of resistant variety

may contain substances inhibitory for *Fusarium* growth ; such type of resistance is known as chemical resistance.

There are many examples which manifest such type of chemical resistance. The presence of catechol and protocatechuic acid in cell-sap of coloured resistant onion varieties is believed to account for the resistance of these varieties to onion smudge caused by *Colletotrichum circinans* (Link and Walker 1933). The action of volatile and non-volatile antibiotics in the fleshly scales of onion is considered also to be a definite factor in the relative resistance of onion varieties to *Colletotrichum circinans, Aspergillus niger* and *Botrytis allii* (Hatfield and others 1948). The immunity of monocotyledonous plants to *Phymatotrichum omnivorum* is found to be due to certain unidentified ether-soluble substances present in monocotyledonous plants, but apparently absent in most or all dicotyledonous ones (Ezekial and Fudge 1938). The presence of a high amount of glucosides accounts for the resistance of flax varieties to *Fusarium lini* (Reynolds, 1924 and 1931) and of crucifers to clubroot (Rochlin, 1934). Similarly, the resistance of a species of *Solanum* to *Cladosporium fulvum* is believed to be due to the presence of higher amounts of solanine (Schmidt, 1933 and Brown, 1936). Fontaine and others (1947) suggested that tomatin may be a factor in the resistance of certain tomato varieties to *Fusarium lycopersici*. Little and Grubauch (1946) demonstrated that both *Fusarium conglutinans* and *Fusarium lycopersici* were inhibited by juices from wilt-resistant tomato varieties. A substance antagonistic to a number of bacteria and fungi, among which was *Fusarium lycopersici,* could be detected in cabbage seed extracts (Lucas and others 1946). Antifungal substances were isolated from the storage organs of turnip, Kohlrabi and beet (Gerretsen and Haagsma, 1951). Braun (1942), working on the relative susceptibility of two watermelon varieties to wilt disease due to *Fusarium bulbigenum* variety *niveum,* found that the fungal growth in the less susceptible variety might be retarded by a water-soluble substance extracted from the shoot and not from the root as the pathogen established itself in the roots of both varieties ; ether extracts from dried pulps of both varieties did not affect growth.

Some substances, such as phenols (Newton and Anderson, 1929; Dufernoy and Edgerton 1940, and Greathouse and Rigler, 1940) or tannins (Cook and Wilton, 1911, and Cartwright and

Findlay, 1947), are generally associated with resistance. The tannin content of wood is inversely proportional to the rate of advance of certain heart-rot fungi (Lutz, 1928). Walker and Link (1935) stated, however, that phenolic compounds were not always a factor in resistance as they might be present in concentrations that have either no or even a stimulating effect on fungal growth.

2. EXPERIMENTAL TECHNIQUE

Fusarium mycelial growth, as determined by either growth rates on agar cotton extracts or mycelial dry weights on liquid extracts, has been elucidated in response to the variation of the following factors of cotton extracts : (i) The cotton variety used; (ii) Stage of seedling maturation; (iii) The plant part (i.e. seeds, whole seedlings, shoots or roots), and (iv) Sterilization-treatment of the extract, whether heat-sterilized by autoclaving or cold-sterilized by Menon's technique (Menon, 1934). The latter involves the transference of the extract into an ice chest for 24 hours, heated for ten minutes at 60°C, and then rapidly transferred again to the ice chest ; the whole process has to be repeated for three consecutive times. A comparison of the fungal growth on the same type of extract, either autoclaved or cold-sterilized, evaluates the possible effect of heat. In each type of the above treatments, varying concentrations of extracts have been used. In addition, the effect of different treatments and concentrations of cotton extracts, on conidial germination, has been studied.

Accordingly, the present cultural work, will include the study of : (1) Growth responses of *Fusarium* — as measured by growth rates on agar media — to different treatments of aqueous cotton extracts ; (2) Growth responses of *Fusarium* — as measured by mycelial dry weights — to different treatments of aqueous cotton extracts ; (3) Effect of individual components of cotton extracts — as separated by differential dissolution in various organic solvents — on *Fusarium* growth, and (4) Germination potentialities of *Fusarium* conidia as influenced by the nature and treatment of cotton extract.

The following method has been applied throughout for the preparation of different cotton extracts : Two- and four-weeks old healthy seedlings, of either the resistant "Karnak" or the susceptible "Giza 26" cotton variety, were pulled out carefully

from the soil and washed thoroughly under running tap water for several hours. They were then dried in between blotting papers. In every case, 100 grams were weighed from either: (a) Seeds; (b) Whole seedlings; (c) Seedling shoots, or (d) Seedling roots. Each lot was cut into small pieces and washed, for several times, with sterilized water. They were then transferred into an electric grinding machine and pounded — for a period of five minutes — at full speed. The pounded extract was treated with sterilized water, filtered off, and the residue was subsequently washed for several times. The filtrate, as well as the aqueous solution resulting from washing the residue, were completed to one litre. From this 10% aqueous cotton extract the following dilutions were also prepared : 2%, 4%, 6% and 8%. For each treatment and concentration, the extract was divided into two portions: one portion was autoclaved and the other cold-sterilized.

3. GROWTH RESPONSES OF FUSARIUM — AS MEASURED BY GROWTH RATES ON AGAR MEDIA — TO DIFFERENT TREATMENTS OF AQUEOUS COTTON EXTRACTS.

Petri-dishes, containing different types and treatments of aqueous cotton extract to which 2% agar was added, were inoculated with *Fusarium* mycelial discs of a standardized size and incubated at 25°C. Comparisons of *Fusarium* mycelial growth will be made according to the following sequence of extracts from : (i) "Giza 26" or "Karnak" seeds; (ii) "Giza 26" or "Karnak" two- and four-weeks old whole seedlings; (iii) Roots of either "Giza 26" or "Karnak" two- and four-weeks old seedlings; (iv) Shoots of either "Giza 26" or "Karnak" two- and four-weeks old seedlings, and (v) 10% concentration of "Giza 26" and of "Karnak" cotton extracts, from seedlings of different stages of maturation, compared with a synthetic medium of a known chemical constitution (i.e. autoclaved Richard's solution agar). The results are expressed as growth rates and represented almost diagramatically (Figs. 1 - 6).

In such growth-rate curves, three phases could be distinguished :

a) An initial phase, during which the growth rate remains variable — with increasing incubation period — until it reaches its optimal value.

b) Optimal phase, in which daily increment attains its highest value.

c) Post-optimal phase, during which the growth-rate procedure behaves in either one of the two following ways: (i) It remains more or less constant — throughout the remaining incubation period — and this occurs in the absence of staling, or (ii) It starts to decrease successively with increasing incubation period above the optimal phase, and this designates the occurrence of the staling phenomenon.

There are two points to be considered in discussing the various growth-rate curves on different types, treatments or concentrations of cotton extracts: (1) The occurrence of staling indicates the production — as a result of fungal growth — of certain metabolites suppressive for its own growth, and (2) the successive lowering of optimal phases, with increasing extract concentration, denotes the possible presence of an inhibitory factor in the tested extract.

(i) Seed Extracts (Fig. 1):

Concerning different concentrations and treatments of "Giza 26" and "Karnak" seed extracts, the procedures of growth rate curves — during the whole incubation period — do not vary considerably on the autoclaved and cold-sterilized same seed extract but they are comparatively higher on autoclaved extracts. Staling occurs on different seed cotton extracts, although it is comparatively more pronounced on "Karnak" than on "Giza 26" seed extracts.

(ii) Whole Seedling Extracts (Fig. 2):

Except in two remarkable cases (i.e. 10% "Giza 26" two-weeks old seedling extracts and 6% "Karnak" four-weeks old seedling extract), no significant difference can be detected in procedures of growth-rate curves on the same seedling extract either autoclaved or cold-sterilized; the growth-rate curve on autoclaved extract lies generally, however, above that on the same extract cold-sterilized. The successive depression in optimal phases of growth-rate curves, with increasing concentrations of "Karnak" two-weeks old seedling extract (Fig. 2, 1), might indicate the presence of an inhibitory factor for fungal growth, similar inhibitory effect is also shown on "Karnak" four-weeks old seedling extract (Fig. 2, 11) which is

more manifested at higher experimental concentrations. Accordingly, an increase in the concentration of such an inhibitory factor — following increase of extract concentration — causes a successive depression of the optimal phases of growth-rate curves. No such effect could be detected, however, on increasing concentration of "Giza 26" two-weeks old seedling extract. On the contrary, in case of four-weeks old "Giza 26" seedling extract, the optimal phases becomes successively elevated with gradual increasing concentrations of the extract.

Staling is found to occur on whole-seedling extracts of the two experimental cotton varieties; it is, however, more pronounced on extracts from "Karnak" than from those of "Giza 26" cotton variety. The procedure of staling, in response to increased maturation of cotton seedlings, differs on corresponding extracts — of similar treatment and concentration — of the two cotton varieties. It becomes more pronounced with increasing maturation of "Karnak" seedlings, while less pronounced with increased maturation of "Giza 26" seedlings. This might indicate that the metabolitic activity of *Fusarium* results in causing a more suppression for its own growth with increased "Karnak" seedling maturation, while the reverse condition occurs in case of "Giza 26" seedlings.

(iii) Root Extracts (Fig. 3):

The variation in the method of treatment of each particular type of root extract, whether cold-sterilized or autoclaved, is not found to affect appreciably the mode of procedure of growth-rate curves at each particular concentration of extract. An increase in the concentration of two-weeks old "Giza 26" seedling root extract causes a successive elevation of the optimal phases, while no such effect could be detected on root extracts of "Karnak" seedlings of a similar age. Staling is found to occur on all concentrations of root extracts from either "Giza 26" or "Karnak" two-weeks old seedlings; on both types of root extracts, staling becomes either partially or completely eliminated with the advance of seedling maturation.

(iv) Shoot Extracts (Fig. 4):

As in the case of root extracts, there is generally no appreciable difference in the procedures of growth-rate curves on the same shoot extract whether autoclaved or cold-sterilized. The

depression in growth-rate curves on "Karnak" shoot extracts, compared in two- and in four-weeks old seedlings, shows that "Karnak" shoots become less favourable for *Fusarium* with increasing seedling maturation. Growth-rate curves on shoot extracts, from either "Giza 26" or "Karnak" four-weeks old seedlings, show that increasing concentration causes successive elevation on "Giza 26" extract and gradual depression on "Karnak" extract. The more favouritism of "Giza 26" shoot extract and the less convenience of that of "Karnak" for fungal growth, with increasing seedling maturation, are further supported by the sequence of staling in both cases. It is found to become less pronounced on "Giza 26" extract, and appreciably more pronounced on that of "Karnak," with increased maturation of respective seedlings.

(v) Comparison:

A comparison has been made of growth-rate curves at the maximal experimental concentration (i.e. 10%) of different types and treatments of cotton extracts in relation to those on autoclaved Richard's solution agar as a standardized control medium of known constitution; the results can be summarized as follows (Figs. 5 and 6): (1) Except on seed extract, the growth-rate curves of *Fusarium* become comparatively depressed on similar parts and concentrations of "Karnak" than of "Giza 26"; this denotes the more favouritism of the latter cotton variety; (2) The remarkable depression of growth-rate curves, compared on four- and two-weeks old "Karnak" whole seedling and shoot extracts, might indicate that "Karnak" shoots and whole seedlings become gradually more suppressive for *Fusarium* growth with their increased maturation; (3) On differently treated extracts from various parts of two-weeks old seedlings, of either "Giza 26" or "Karnak" cotton variety, *Fusarium* shows staling. On the other hand, on the control Richard's solution agar, the growth rate remains more or less constant throughout the post-optimal phase which indicates the non-staling type of *Fusarium* growth, and (4) In comparison with the control synthetic medium, staling becomes less pronounced on differently treated extracts from different parts of four-weeks than on two-weeks old "Giza 26" seedlings. On the other hand, an increased depression of growth-rate curves on extracts of different parts of "Karnak" seedlings, as well as the occurrence of a very pro-

nounced staling on shoot and whole-seedling extracts, take place on "Karnak."

4. — GROWTH RESPONSES OF FUSARIUM — AS MEASURED BY MYCELIAL DRY WEIGHTS — TO DIFFERENT TREATMENTS OF AQUEOUS COTTON EXTRACTS.

Fusarium growth responses to liquid aqueous cotton extracts have been similarly tested by mycelial dry-weight determinations. Cultures were incubated, for ten days, at 30°C, the mycelial growth was then filtered off, dried at 80°C for 48 hours, and the dry weight was determined.

Concerning seed extracts (Fig. 7), *Fusarium* mycelial growth is always significantly greater on "Giza 26" seed extracts than on those from "Karnak." The fungus behaves also differently in response to increasing concentration of the two types of seed extracts. The mycelial dry weights continue to increase constantly with increasing concentration of "Giza 26" seed extract while — in case of "Karnak" seed extract — the increase contiues up to a certain concentration (i.e. 8%), above which the growth starts to degrade. In all experimental seed-extract concentrations of the two cotton varieties, autoclaving results in increasing *Fusarium* growth in comparison with corresponding cold-sterilized extracts. This suggests either the possible presence of a thermolabile growth-inhibiting factor or that autoclaving changes the chemical constitution of the extract in such a way as to become more favourable for fungal growth.

Concerning whole-seedling extracts (Fig. 8,1), in all concentrations, the fungal growth is significantly greater on "Giza 26" than on "Karnak" extracts from seedlings of a similar age as well as on extracts from four-weeks than from two-weeks old seedlings. On the whole, autoclaving results in causing an increase in *Fusarium* growth in a similar manner — and possibly due to the same reasons — previously mentioned in seed extracts. The procedure of *Fusarium* growth curve — in response to increasing extract concentrations — differs in the two cotton varieties. On "Giza 26" extacts, from seedlings of varying maturation, the growth continues to increase with increasing experimental concentrations; the rate of increase is, however, greater on extracts from four-weeks old seedlings. On the other hand, in all treatments of "Karnak" extracts, the fungal growth continues to increase with increasing concentration up to a maximal value (i.e. about 6%), above which there is an abrupt and continual degradation with increasing concentration. This may indicate the presence of an inhibitory factor in "Karnak" extract, which becomes more pronounced at higher concentrations. It would be of interest, therefore, to elucidate the relative distribution and potency of this factor in the component parts of the same cotton seedling (i.e. shoot and root).

Concerning shoot extracts (Fig. 8,11), the lowest growth is shown on extracts from two-weeks old "Karnak" seedlings; there is also a remarkable degradation in the growth curve at higher concentrations. This might indicate the presence of an inhibitory factor in such extract. *Fusarium* growth becomes, however, considerably greater on four-weeks old "Karnak" seedling extract. Although — on "Karnak" shoot extracts — the mycelial dry weights become significantly greater with the advance of seedling maturation, yet the growth curve starts still to show degradation at highest experimental concentration. On "Giza 26" shoot extracts, there is a constant increase in dry mycelial weights with increasing experimental concentrations, but the rate of increase is greater on extracts from four-weeks than from two-weeks old seedlings.

Root extracts (Fig. 8,111), from two-weeks old "Karnak" or "Giza 26" seedlings, are proved to be inhibitory for *Fusarium* growth; there is a constant decrease in mycelial weights with increasing concentration. On four-weeks old "Giza 26" seedling root extracts, the gradual constant increase in *Fusarium* mycelial weights with increasing extract concentration denotes the deactivation of the inhibitory factor with advanced seedling maturation. In a similar manner, the inhibitory factor is only partially deactivated with increased maturation of "Karnak" seedling roots.

The present cultural experiments reveal the possible presence of an inhibitory factor — for *Fusarium growth* — in "Karnak" shoots or roots, as well as in "Giza 26" roots, of two-weeks old seedlings. Although these experiments have indicated the presence of an inhibitory factor in certain types of cotton extracts, yet they do not elucidate its real nature. The inhibitory factor may be either of nutritive or chemical nature; the former is due to the increasing concentration of certain nutritive constituents of the extract, and the latter is due to the presence of certain fungicidal or fungistatical chemical substances. Accordingly, it is found rather essential to take advantage of the

differential dissolution of the latter substances in certain organic solvents to determine their possible presence and identity ; this has been approached by the two following methods : (A) Ring-test experiments, and (B) Mycelial dry weights.

5. — EFFECT OF INDIVIDUAL COMPOUNDS OF COTTON EXTRACTS — AS SEPARATED BY DIFFERENTIAL DISSOLUTION IN VARIOUS ORGANIC SOLVENTS — ON FUSARIUM GROWTH.

(A) Ring-test experiments:

In addition to aqueous cotton extracts, alcohol, petroleum ether and ether extracts were also prepared. Extracts were obtained from seeds, whole seedlings (two- and four-weeks old), seedling roots and shoots, of either "Karnak" or "Giza 26" cotton variety. In every case, the plant material — after being washed thoroughly — was pounded with sterilized water. The resulting paste was then mixed with 250 c.c. of the experimental organic solvent, and further pounded — for five minutes — in an electric grinding machine. The material was left — in contact with the solvent — for 48 hours. It was shaken from time to time, then decanted, filtered off, and the solvent was evaporated under reduced pressure. The residue, left after evaporation, was dissolved in sterilized water and diluted to the respective 10% concentrations; dilutions were further made into: 2%, 4%, 6% and 8%. The aqueous solution was subsequently either autoclaved or cold-sterilized. A ring — of about 6 mms. in diameter — was removed under aseptic conditions from the middle of petri dishes containing Richard's solution agar. Each dish was then flooded with 10 c.c. of *Fusarium* conidial suspension, left for five minutes, and the excess was decanted off. Four drops, of the experimental cotton extract, were then added in place of the removed agar ring; four dishes were used for every particular type of extract treatment. All cultures were incubated at 25°C and examined carefully every day. The total diameter of the neutral zone, formed around the ring, is considered as a criterion for the presence and relative potency of the inhibitory factor present in the tested extract.

The present ring-test experiments (Table 1 and Fig. 9) indicate the presence in "Karnak" two-weeks old seedlings, as well as in their respective roots and shoots, of water-soluble and

TABLE I

Growth responses of *Fusarium,* as demonstrated by ring-test experiments, on various components — as dissolved in different organic solvents — of extracts from : whole seedlings (W.S) of different stages of maturation as well as from their respective roots (R) and shoots (S) of either "Giza 26" (G) or "Karnak" (K) cotton variety ; fungal inhibition is expressed as (±) and free development as (—).

Seedling age:	Cotton Variety	Plant part	Extraction by: Water	Alcohol	Petroleum ether	Ether
Two-weeks old	(G)	(W.S	(–)	(–)	(–)	(±)
		(R)	(–)	(–)	(–)	(±)
		(S)	(–)	(–)	(–)	(+)
	(K)	(W.S)	(±)	(–)	(–)	(±)
		(R)	(±)	(–)	(–)	(±)
		(S)	(±)	(–)	(–)	(±)
Four-weeks old	(G)	(W.S)	(–)	(–)	(–)	(–)
		(R)	(–)	(–)	(–)	(–)
		(S)	(–)	(–)	(–)	(–)
	(K)	(W.S)	(–)	(–)	(–)	(–)
		(R)	(–)	(–)	(–)	(–)
		(S)	(–)	(–)	(–)	(–)

ether soluble inhibitory substances for *Fusarium* growth. In case of ether-soluble components, the greatest inhibition was manifested by the root extract while that of shoot had a comparatively lower inhibitory effect (Fig. 9, 11 C and D). Similarly, the potency of the inhibitory factor was detected in "Giza 26" however, except in the ether-soluble components of either whole seedling or root extracts of two-weeks old; the latter express a comparatively weaker effect than corresponding component present in "Karnak" root extract. On the other hand, no inhibitory effect was exerted by different extract treatments — of varying concentrations — of either: (i) Seeds, (ii) Four-weeks old seedlings, or (iii) Alcohol and petroleum ether extracts.

The failure of detecting inhibitory factors, with increased maturation of seedlings of both cotton varieties (i.e. four-weeks old), may be accounted for by either one of the two following possibilities: (a) The inhibitory effect is only restricted to early stages of seedling development and becomes gradually deteriorated with increased maturation and (b) The inhibitory factor becomes reduced — either in activity or quantity — with increased seedling maturation. Accordingly, quantitative cultural studies will be further carried out to elucidate the fate of such inhibitory factors with increased seedling maturation.

(B) Mycelial dry weights:

By the same method already described, 10% autoclaved or cold-sterilized solutions were prepared from cotton-extract residues left after evaporating the experimental organic solvents (i.e. alcohol, ether and petroleum ether); 5 c.c. of the aqueous solution were then added to every 20 c.c. of Dox's liquid. Controls were also made by using Dox's liquid as well as Dox plus water. Accordingly mycelial discs were transferred into different lots — 25 c.c. each — of the following treatments: (i) 100% Dox's liquid; (ii) 80% Dox plus 20% water; (iii) 80% Dox plus 20% autoclaved extract and (iv) 80% Dox plus 20% cold-sterilized extract. Extracts were obtained from whole seedlings (two- and four-weeks old) as well as from their respective roots and shoots; seed extracts were only prepared as aqueous extracts. For each particular treatment, four flask cultures were used; these were incubated, at 30°C, for ten days. The mycelial growth was then filtered off, dried, and dry weight was determined. Percentage changes were calculated in comparison with Dox's liquid and with Dox's liquid plus water as controls.

The results are found to be more or less in accordance with those obtained from previous ring-test experiments and can be summarized as follows (Fig. 10, Tables II and III): (1) The addition of aqueous root extract from two- weeks old "Karnak" seedlings to Dox's liquid results in suppressing *Fusarium* growth as indicated by the considerable percentage decrease compared with Dox plus water. This water-soluble inhibitory factor seems to be thermostable, since it could not be eliminated through autoclaving; (2) No inhibitory factors could be detected in aqueous extracts from either seeds or roots and shoots of four-weeks old seedlings of both cotton varieties; (3) Concerning ether extracts, considerable percentage decreases occur — in comparison with *Fusarium* mycelial weight on Dox plus water — when the following ether extracts are added to Dox's liquid: (a) Ether extract from roots of two weeks old "Giza 26" seedlings (i.e. amounts to 86%), and (b) Ether extracts from either roots or shoots of two-weeks old "Karnak" seedlings; the percentage decrease is comparatively higher than in "Giza 26" (i.e. amounts to 98%). The persistance of such an inhibitory effect to a more or less equal extent on the same extract, whether cold-sterilized or autoclaved, indicates the thermostability of the inhibitory factor; (4) Inhibitory factors in roots of both cotton varieties, of comparatively very weak potency than those extracted with ether, can be detected in petroleum ether extract, and (5) The considerable increase in *Fusarium* mycelial dry weights on Dox plus alcohol shoot-extract of either one of the two cotton varieties, compared with those on Dox, might be due to the fact that alcohol dissolves most of the mono- and di-saccharides present in the shoot extract.

6. — GERMINATIVE POTENTIALITIES OF FUSARIUM CONIDIA AS INFLUENCED BY THE NATURE AND TREATMENT OF COTTON EXTRACT.

Comparisons of different criteria of *Fusarium* conidial germination have been made with regard to the following aspects: (i) Effect of different concentrations of aqueous extracts (i.e. 2% 4%, 6%, 8% and 10%); and (ii) Effect of 10% aqueous solutions of differently-dissoluted extract components (i.e. aqueous, alcohol, ether and petroleum ether). Aqueous extracts were prepared from seeds, roots and shoots of two-weeks old "Giza 26" or "Karnak" seedlings. In Addition, 10% aqueous solutions were

TABLE II

Percentage changes in *Fusarium* mycelial dry weights on Dox's liquid plus an aqueous cotton extract (D. + W.E.) compared with those on pure Dox's liquid (P.D) and on Dox's plus water (D+W); autoclaved (A) or cold-sterilized (M) aqueous extracts are obtained from seeds (S.D) as well as from roots (R), shoots (S) and whole seedlings (W.S) of either "Giza 26" (G) or Karnak (K) two- and four-weeks old. Percentage increase is symbolized as (+) and decrease as (—).

Medium	Seedling age	Cotton variety	part	Extract treatment	Mycelial weight (in mgms).	% change compared with: (P.D)	(D+W)
(P.D)	–	–	–	–	101.6	–	–
(D + W)	–	–	–	–	86.4	–	–
D.+W.E	–	(G)	(S. D)	(A)	114.8	13 (+)	33 (+)
				(M)	105.8	4 (+)	23 (+)
		(K)	(S.D)	(A)	99.4	2 (—)	15 (+)
				(M)	92.6	9 (—)	7 (+)
	Two-weeks old.	(G)	(W.S)	(A)	94.0	8 (—)	9 (+)
				(M)	90.0	11 (—)	4 (+)
			(R)	(A)	80.0	21 (—)	7 ( )
				(M)	76.2	25 (—)	12 (—)
			(S)	(A)	94.8	7 (—)	10 (+)
				(M)	92.6	9 (—)	9 (+)
		(K)	(W.S)	(A)	82.2	19 (—)	5 (-)
				(M)	80.0	21 (—)	7 (—)
			(R)	(A)	68.2	33 (—)	21 (—)
				(M)	60.0	41 (—)	31 (—)
			(S)	(A)	90.0	11 (—)	4 (—)
				(M)	89.7	12 (—)	4 (+)
	Four-weeks old.	(G)	(W.S	(A)	99.5	2 (—)	15 (+)
				(M)	96.8	5 (—)	13 (+)
			(R)	(A)	90.7	11 (—)	5 (+)
				(M)	90.4	3 (—)	5 (+)
			(S)	(A)	98.8	5 (—)	14 (+)
				(M)	96.1	9 (—)	11 (+)
		(K)	(W.S)	(A)	92.2	9 (—)	7 (+)
				(M)	90.0	11 (—)	4 (+)
			(R)	(A)	88.2	13 (—)	2 (+)
				(M)	88.0	13 (—)	2 (+)
			(S)	(A)	94.2	7 (—)	9 (+)
				(M)	93.6	8 (—)	8 (+)

TABLE III

Percentage changes in *Fusarium* mycelial dry weights on Dox's liquid plus either ether (D+E.E), petroleum ether (D+P.E) or alcohol (D+A.E) cotton extract compared with those on pure Dox's liquid (P.D) and on Dox plus water (D+W); autoclaved (A) or cold-sterilized (M) extracts are obtained from roots (R) and shoots (S) of two-weeks old seedlings of either "Giza 26" (G) or "Karnak" (K) cotton variety. Percentage increase is symbolized as (+) and decrease as (—).

Medium	Cotton variety	Plant part	Extract treatment	Mycelial weight (in mgms).	% change compared with (P.D)	(D+W)
(P. D)	–	–	–	101.6	–	–
(D+W)	–	–	–	86.4	–	–
(D+E.E.	(G)	(R)	(A)	12.7	88 (-)	85 (—)
			(M)	12.2	88 (—)	86 (—)
		(S)	(A)	78.2	23 (--)	9 (--)
			(M)	76.4	25 (-)	12 (-)
	(K)	(R)	(A)	1.8	98 (—)	98 (—)
			(M)	1.8	98 (—)	98 (—)
		(S)	(A)	2.2	98 (-)	98 (—)
			(M)	2.2	98 (—)	98 (—)
(D + P.E)	(G)	(R)	(A)	72.7	28 (—)	16 (—)
			(M)	71.4	30 (—)	17 (—)
		(S)	(A)	82.4	19 (-)	5 (—)
			(M)	80.6	21 (—)	7 (—)
	(K)	(R)	(A)	68.2	33 (—)	21 (-)
			(M)	67.3	34 (—)	22 (—)
		(S)	(A)	80.3	21 (—)	7 (—)
			(M)	78.6	23 (—)	9 (—)
(D+A.E)	(G)	(R)	(A)	96.0	5 ( )	11 (+)
			(M)	93.9	8 (-)	9 (+)
		(S)	(A)	124.2	22 (+)	44 (+)
			(M)	122.2	20 (+)	41 (+)
	(K)	(R)	(A)	102.4	1 (+)	19 (+)
			(M)	101.8	0	18 (+)
		(S)	(A)	126.4	24 (+)	46 (+)
			(M)	121.7	20 (+)	41 (+)

prepared from residual components left after the evaporation of the experimental organic solvents from either seedling root or shoot extracts. All these were cold-sterilized. Hanging-drop cultures in Van-Tieghem cells, containing *Fusarium* conidial suspension of uniform density, were made; duplicates were prepared for each particular treatment and concentration. The cultures were incubated at 25°C and examined after 2, 4, 6, 8, 16and 24 hours respectively. The following criteria have been subsequently determined: (a) Latent period of germination; (b) Rate of germ-tube elongation; and (c) Percentage germination after 24 hours incubation. The presence of an inhibitory factor could be demonstrated by the following effects:

(1) Prolongation of latent period of germination.

(2) Successive depression of germ-tube elongation curves either with increasing concentration of the same extract or with varying nature of extract components as segregated by different organic solvents.

(3) Decrease in final percentage germination in comparison with controls.

The germinative potentialities of *Fusarium* conidia, as influenced by varying concentrations of aqueous cotton extracts as well as by different segregated components in 10% aqueous solutions, can be summarized as follows (Fig. 11 - 13, and Tables IV and V): (i) No inhibitory factor has been detected in seeds of both cotton varieties; (ii) Water-soluble components, suppressive for *Fusarium* conidial germination, are present in roots of both cotton varieties; they are, however, more effective in "Karnak" than in "Giza 26" roots. Similar water-soluble suppressive component is only restricted to "Karnak" shoots; (iii) Ether-soluble components, greatly inhibitory for the germination of both *Fusarium* micro- and macro-conidia, occur in "Karnak" shoot and root extracts; a similar component — of relatively less potency — is restricted only to "Giza 26" root extract; and (iv) Inhibitory components, soluble in petroleum ether and suppressive for conidial germination, are only restricted to "Karnak" and "Giza 26" shoot extracts.

7. — DISCUSSION

In an attempt to elucidate certain aspects of physiological significance of "Karnak" resistance and "Giza 26" susceptibility

TABLE IV

Germination criteria for *Fusarium* micro- or macro-conidia, expressed as latent period of germination and percentage germination, in response to different concentrations of aqueous cotton extracts.

Cotton variety	Extract from:	Extract conc. %	Germination criteria. Latent period Micro	Latent period Macro	% germination Micro	% germination Macro
"Giza 26"	Seeds	2	3	3	41	44
		4	3	3	45	49
		6	3	3	52	58
		8	3	3	55	62
		10	3	3	58	65
	Seedling roots	2	3	3	32	39
		4	3	3	25	34
		6	5	5	20	25
		8	5	5	15	19
		10	5	5	15	18
	Seedling Shoots	2	3	3	38	32
		4	3	3	44	40
		6	1	1	48	44
		8	1	1	40	42
		10	1	1	45	54
"Karnak"	Seeds	2	3	3	52	48
		4	3	3	45	42
		6	3	3	50	50
		8	3	3	52	58
		10	3	3	56	60
	Seedling roots	2	3	3	23	38
		4	7	5	17	20
		6	7	7	11	15
		8	12	7	10	10
		10	12	12	9	10
	Seedling Shoots	2	3	1	45	48
		4	5	3	40	42
		6	5	3	32	38
		8	7	3	28	30
		10	7	5	18	24

TABLE V

Germination criteria for *Fusarium* micro- or macro-conidia, expressed as latent period of germination and percentage germination, in response to 10% concentration of differently-treated cotton extracts; a latent period of germination, which exceeds 24 hours, is expressed as (< 24).

Extract from:	Cotton Variety	Type of extract	Germination criteria			
			Latent period		% germination	
			Micro.	Macro.	Micro.	Macro.
Seeds	"Giza 26"	Aqueous	3	3	58	65
	"Karnak"	Aqueous	3	3	56	60
Seedling roots	"Giza 26"	Aqueous	5	5	15	18
		Alcohol	5	5	25	32
		Petroleum ether	1	3	22	35
		Ether	12	12	7	9
	"Karnak"	Aqueous	12	12	9	10
		Alcohol	3	3	29	32
		Petroleum ether	3	3	30	37
		Ether	<24	<24	0	0
Seedling shoots	"Giza 26"	Aqueous	1	1	45	54
		Alcohol	5	5	17	20
		Petroleum ether	7	12	7	19
		Ether	7	7	22	28
	"Karnak"	Aqueous	7	5	18	24
		Alcohol	3	3	20	23
		Petroleum ether	7	7	11	29
		Ether	<24	<24	0	0

to *Fusarium* cotton-wilt, during post-penetration phase of fungal invasion, the possible presence of inhibitory components — for *Fusarium* mycelial growth and conidial germination — has been tested for in different types of cotton extracts by the following cultural methods: (i) Growth-rate curves, (ii) *Fusarium* mycelial dry-weight determinations; (iii) Ring-test experiments; and (iv) *Fusarium* conidial germinative potentialities. Certain inhibitory chemical components-suppressive for *Fusarium* mycelial growth and conidial germination — have been detected in extracts from both "Karnak" roots and shoots; these thermostable inhibitory components are water- as well as ether-soluble. No conclusion could be derived, however, as to whether the inhibitory factor is of simple or complex nature. In other words, whether the same inhibitory substance shows varying degrees of solubility in water and different organic solvents or whether it consists of a number of individual components varying among themselves in their solubilities in water and organic solvents. On the other hand, its presence is only restricted to "Giza 26" roots and is mainly ether-soluble; its effect seems not to be so potent as to interfere with the further advance of the fungal pathogen.

It is interesting to recall here the previous work done by Marchlewski (1899) and recorded by Thorpe (1939). They stated that cotton seed contains, in addition to oil, a highly toxic phenolic substance "gossypol" which remains dissolved in the oil. This substance has been isolated by extraction with ether; other forms such as apo-gossypol and D-gossypol, which are less toxic, are liable to exist. In a similar manner, ether-soluble substances inhibitory for *Fusarium* growth are detected in two-weeks old "Karnak" seedlings and in "Giza 26" roots. The presence of comparable inhibitory compounds in juices and extracts of various fungal-resistant plants was recorded by various investigators (Newton and Anderson, 1929; Reynolds, 1931; Link and Walker, 1933; Schmidt, 1933; Brown, 1936; Ezekial and Fudge, 1938; Dufrenoy and Edgerton, 1940; Greathouse and Rigler, 1940; Braun, 1942; Lucas and other, 1946; Fontaine and co-workers, 1947; Hatfield and others, 1948; Gerretsen and Haagsma, 1951; and many others).

The main difference between the two cotton varieties lies in the complete absence of inhibitory factors from "Giza 26" shoots and their presence and high potency in "Karnak" shoots. On the other hand, they are present in roots of both cotton

varieties ; those present in "Karnak" roots are, however, of more complex nature and greater potency. In addition, the inhibitory factor in "Giza" roots becomes gradually deteriorated with increasing seedling maturation. Roots of two-weeks old seedlings of both cotton varieties manifest inhibitory effect ; extracts from roots of four-weeks old "Karnak" seedlings still maintain their inhibitory effect especially at higher concentrations, while no such effect could be demonstrated in extracts from roots of four-weeks old "Giza 26" seedlings. This may denote that increased seedling maturation of "Giza 26" renders it more favourable for *Fusarium* mycelial advance, while no such case occurs on increased maturation of "Karnak" seedlings. The coincidence between increased staling with advanced "Karnak" seedling maturation and the simultaneous presence of an inhibitory complex in both its roots and shoots on one hand, and the coincidence between decreasing staling with increased "Giza 26" seedling maturation and the absence of any inhibitory factor in its shoots on the other hand, may partially contribute to the relative resistance of "Karnak" and suscepibility of "Giza 26" cotton varieties to *Fusarium* wilt. The great complexity and high potency of the inhibitory factor present in both "Karnak" roots and shoots may be of such a degree as to interfere with *Fusarium* free post-penetration mycelial advance, while that — restricted to "Giza 26" roots — is comparatively of a simpler nature and not so potent as to oppose fungal development. Since the phenomenon of staling serves only as a qualitative indication of the possible rôle of fungal metabolites in influencing its own further mycelial growth, confirmatory quantitative studies will constitute the subject matter of the following paper.

8. — SUMMARY

(1) An elucidation of the possible presence of inhibitory substances as an expression of chemical resistance against *Fusarium* wilt — has been made with either "Karnak" or "Giza 26" cotton extracts from different seedling parts and from seedlings of different ages.

(2) *Fusarium* growth-rate curves, on certain types and treatments of aqueous cotton extracts, have evaluated the presence of inhibitory factors as well as the occurrence of staling as an expression of the possible production of inhibitory metabolites.

(3) The presence of inhibitory factors, in different types and treatments of aqueous cotton extracts, has been further emphasized by *Fusarium* mycelial dry-weight determinations at increasing extract concentrations. An inhibitory factor has been demonstrated in : (a) Two- and four-weeks old "Karnak" whole seedlings ; (b) Shoots and roots of either two- or four-weeks old "Karnak" seedlings ; and (c) Roots of two-weeks old "Giza 26" seedlings.

(4) Ring-test experiments have been carried out with different aqueous cotton extracts. Water-soluble components, inhibitory for *Fusarium* mycelial growth, could only be detected in different parts of two-weeks old "Karnak" seedlings.

(5) Ring-test experiments, with aqueous solutions — of a similar concentration — of different cotton extract components separated by various organic solvents, have demonstrated the presence of ether-soluble inhibitory components for *Fusarium* mycelial growth in different parts of two-weeks old "Karnak" seedlings. On the other hand, they are only restricted to "Giza 26" roots and are comparatively of less potency than those in "Karnak" roots.

(6) Quantitative determination of *Fusarium* mycelial growth, in response to addition of aqueous extracts or of aqueous solutions of residual extract components — separated by various organic solvents to Dox's liquid, emphasizes the previous results as follows :

a) Ether-soluble thermostable inhibitory components in "Karnak" shoots and roots, as well as in "Giza 26" roots, of two-weeks old seedlings.

b) Water-soluble thermostable inhibitory component in roots of two-weeks old "Karnak" seedlings.

(7) Different components of cotton extracts, as separated by differential solubility in water and various organic solvents, were tested for their inhibitory effect on the germinative potentialities of *Fusarium* conidia.

(8) Both water-soluble and ether-soluble components, inhibitory for *Fusarium* conidial germination, are present in roots of both cotton varieties as well as in "Karnak" shoots. In addition, inhibitory components — soluble in petroleum ether — are proved to exist in shoot extracts of both cotton varieties.

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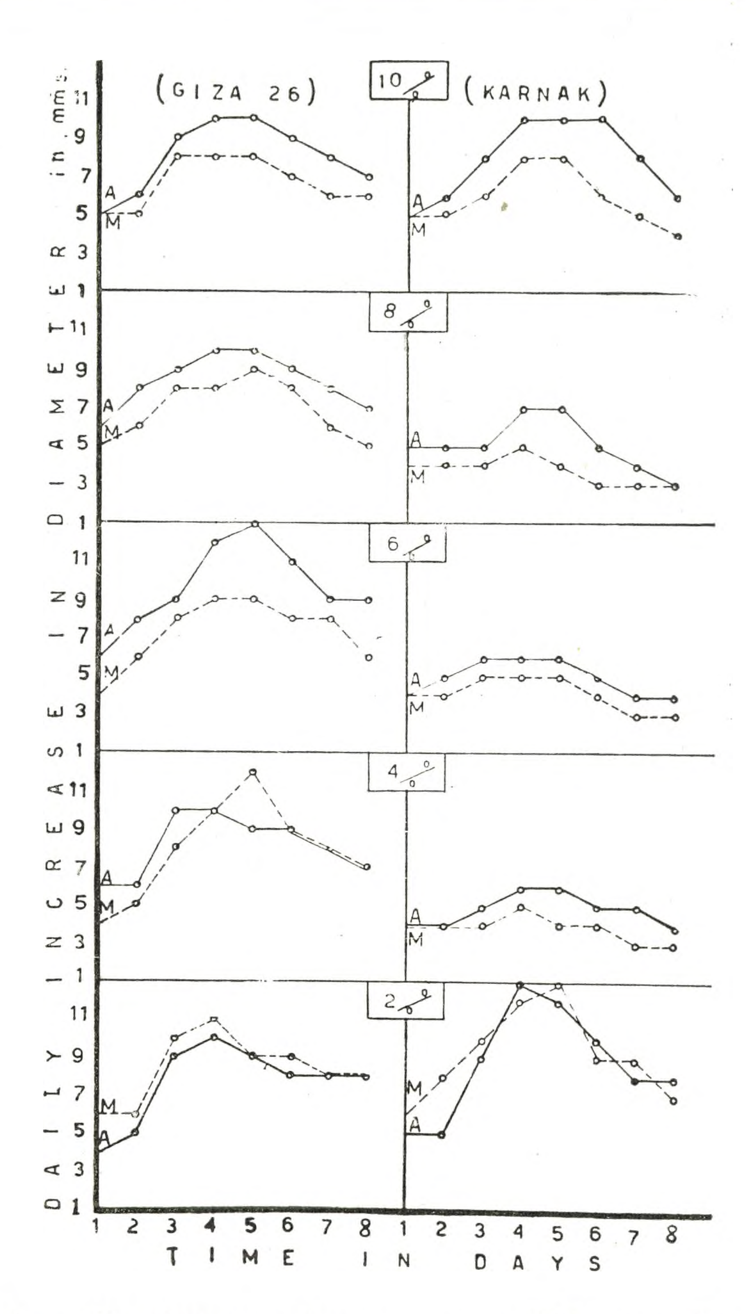


Fig. 1. — *Fusarium* growth-rate curves, at 25°C, on varying concentrations of agar aqueous extracts from "Giza 26" and "Karnak" Cotton seeds; each type of extract is applied either autoclaved (A) or cold-sterilized (M).

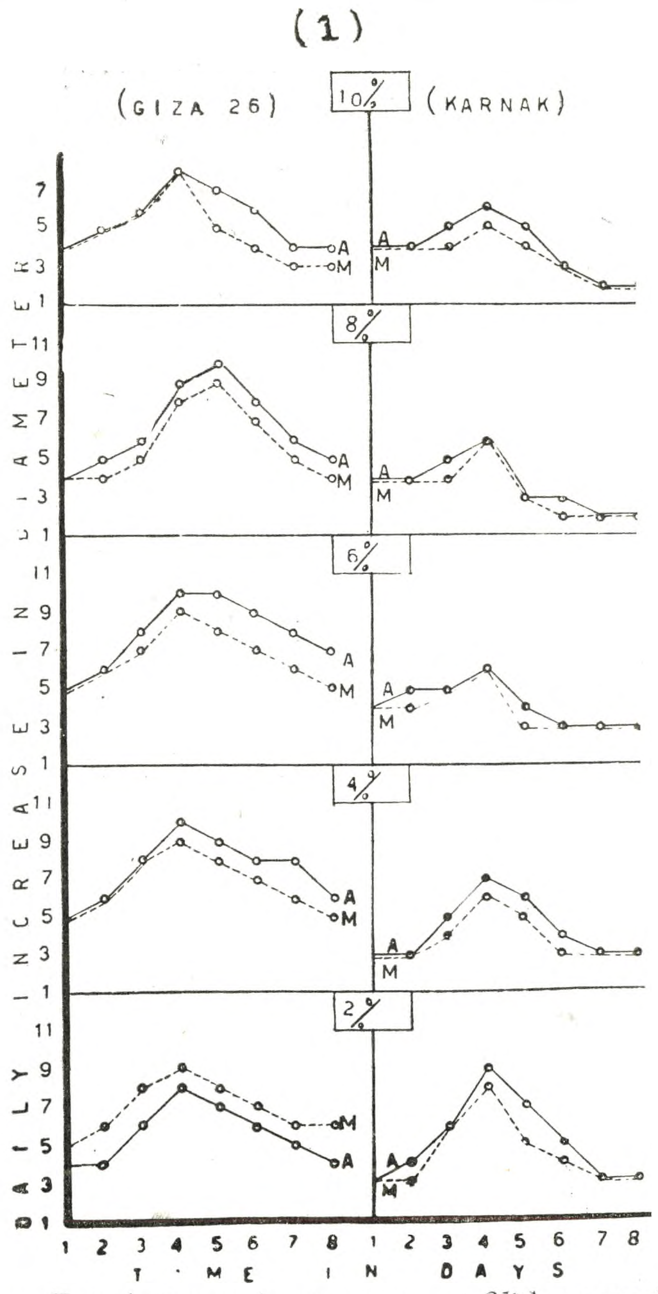
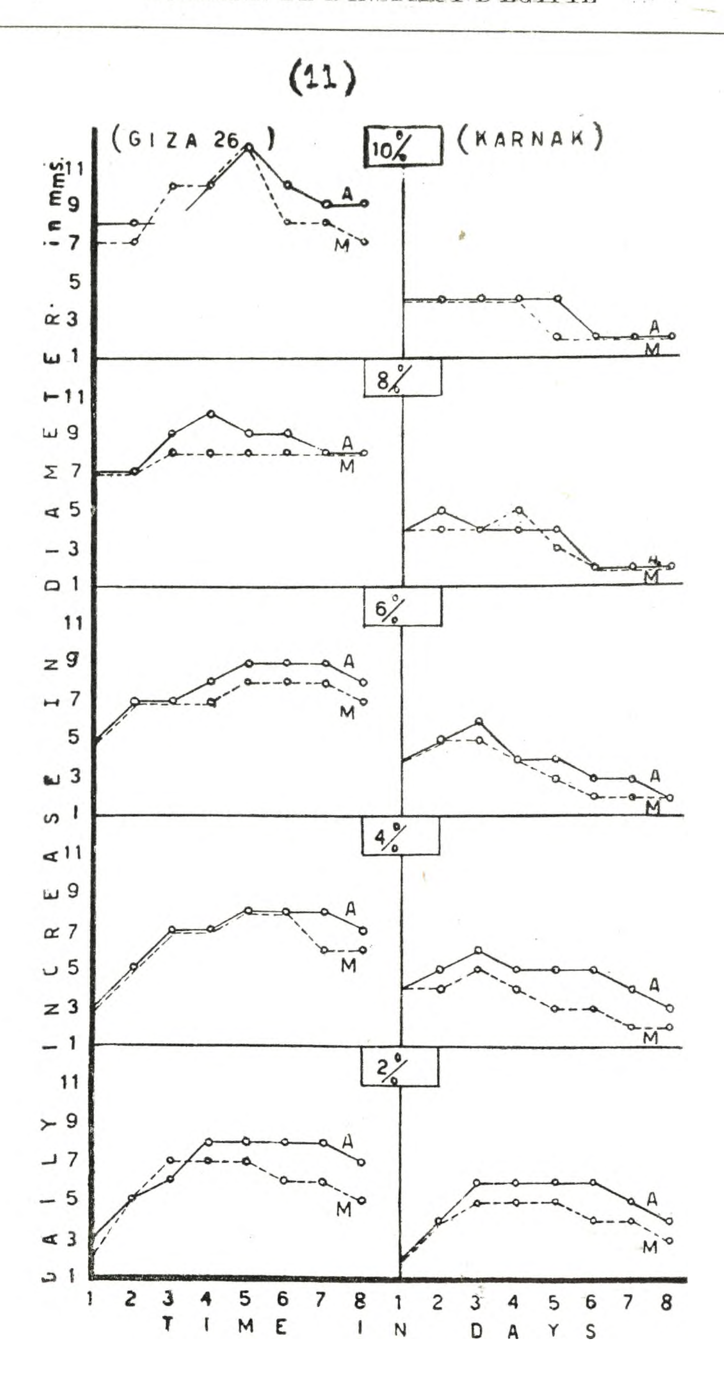


Fig. 2 — *Fusarium* growth-rate curves, at 25°C, on varying concentrations of agar aqueous extracts from either two-weeks (I) or four-weeks (II) old "Giza 26" and "Karnak" cotton whole seedlings; each extract treatment is applied either autoclaved (A) or cold-sterilized (M).



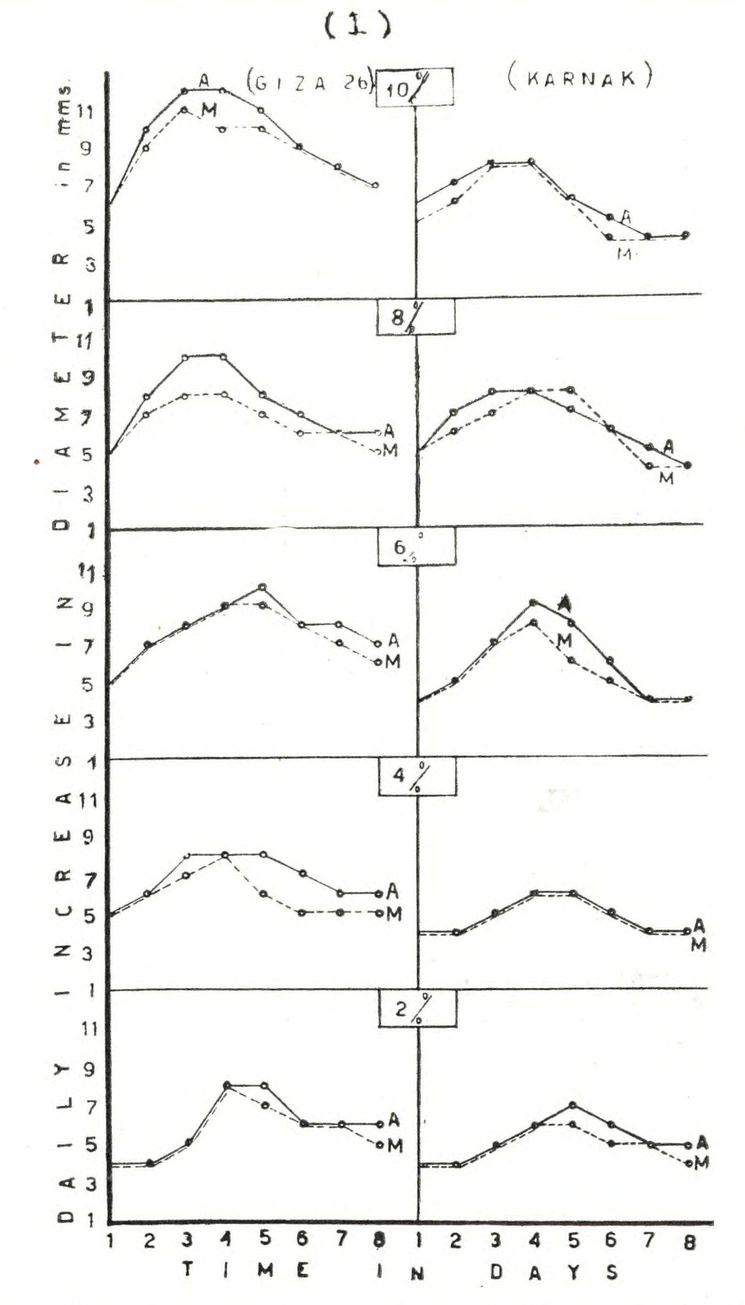
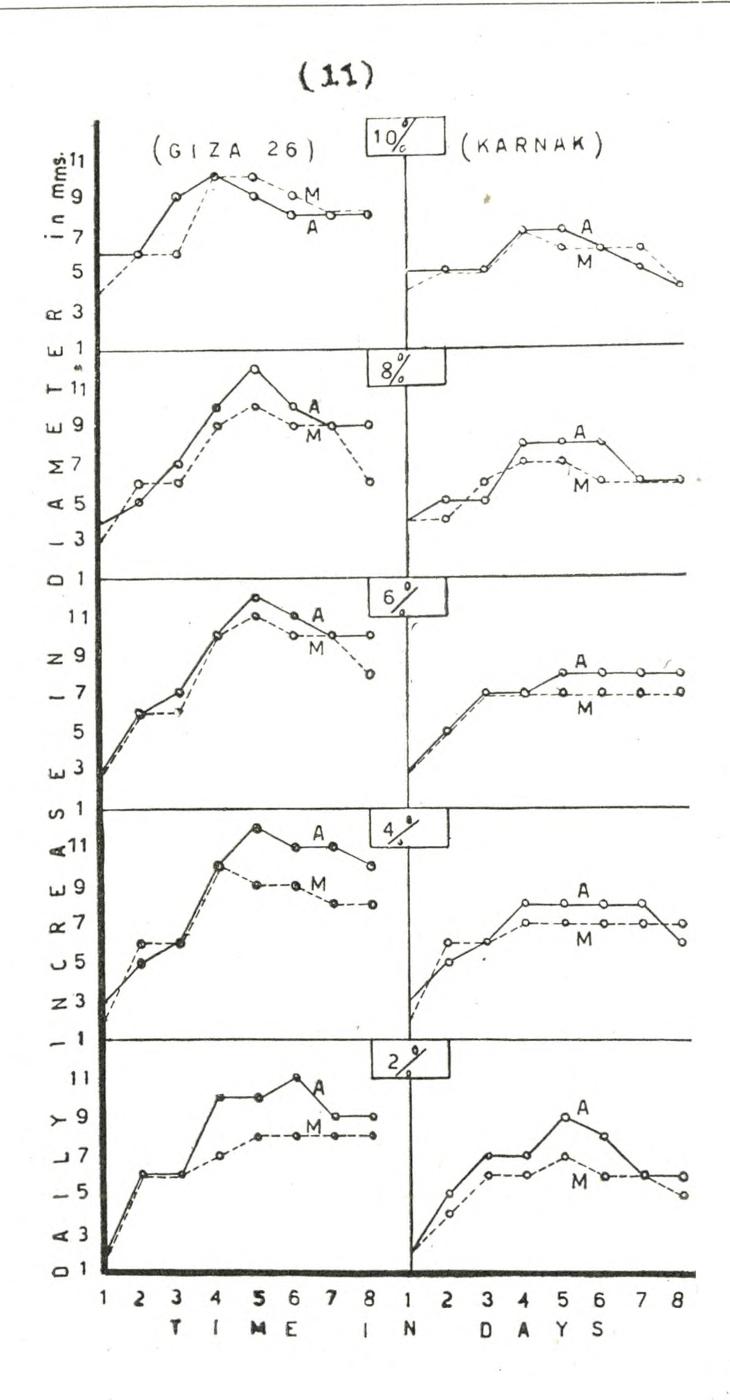


Fig 3. — *Fusarium* growth-rate curves, at 25°C, on varying concentrations of agar aqueous extracts from "Giza 26" and "Karnak" cotton roots of either two-weeks (I) or four-weeks (II) old seedlings; each type of extract is applied either autoclaved (A) or cold-sterilized (M).



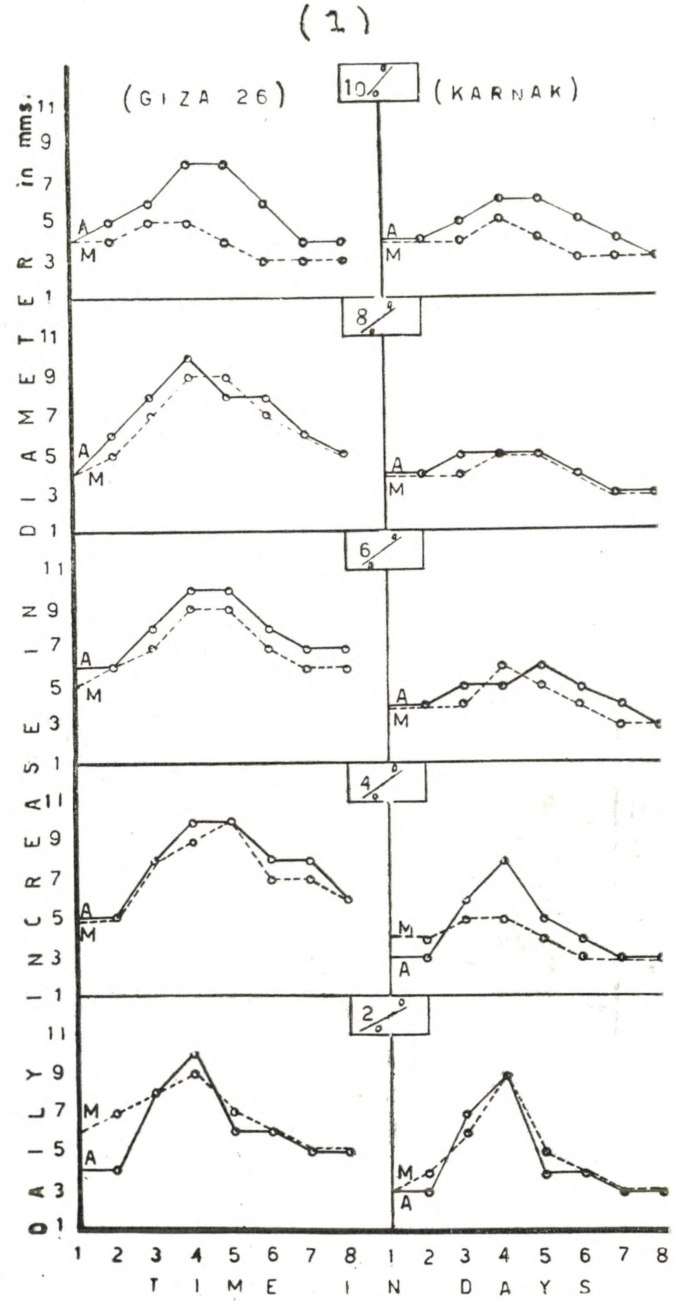
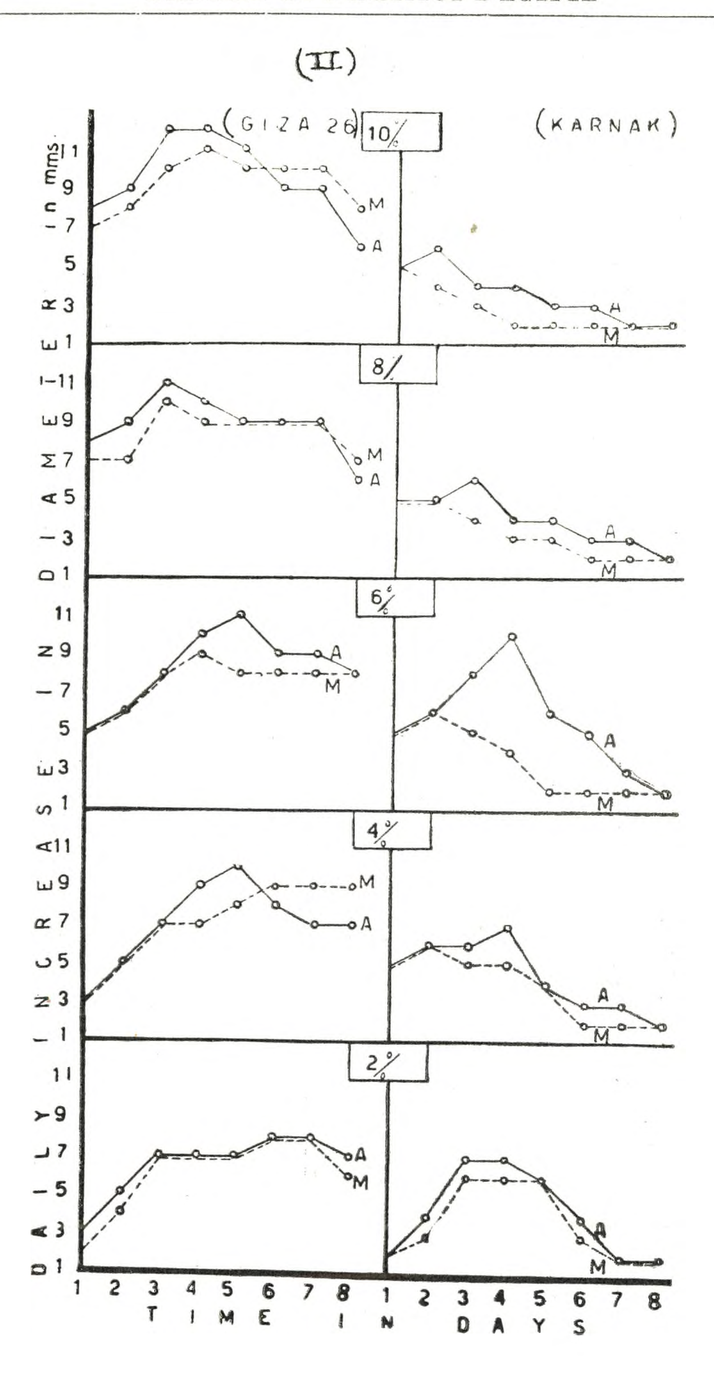


Fig. 4. — *Fusarium* growth-rate curves, at 25°C, on varying concentrations of agar aqueous extracts from "Giza 26" and "Karnak" cotton shoots of either two-weeks (I) or four-weeks (II) old seedlings each type of extract is applied either autoclaved (A) or cold-sterilized (M).



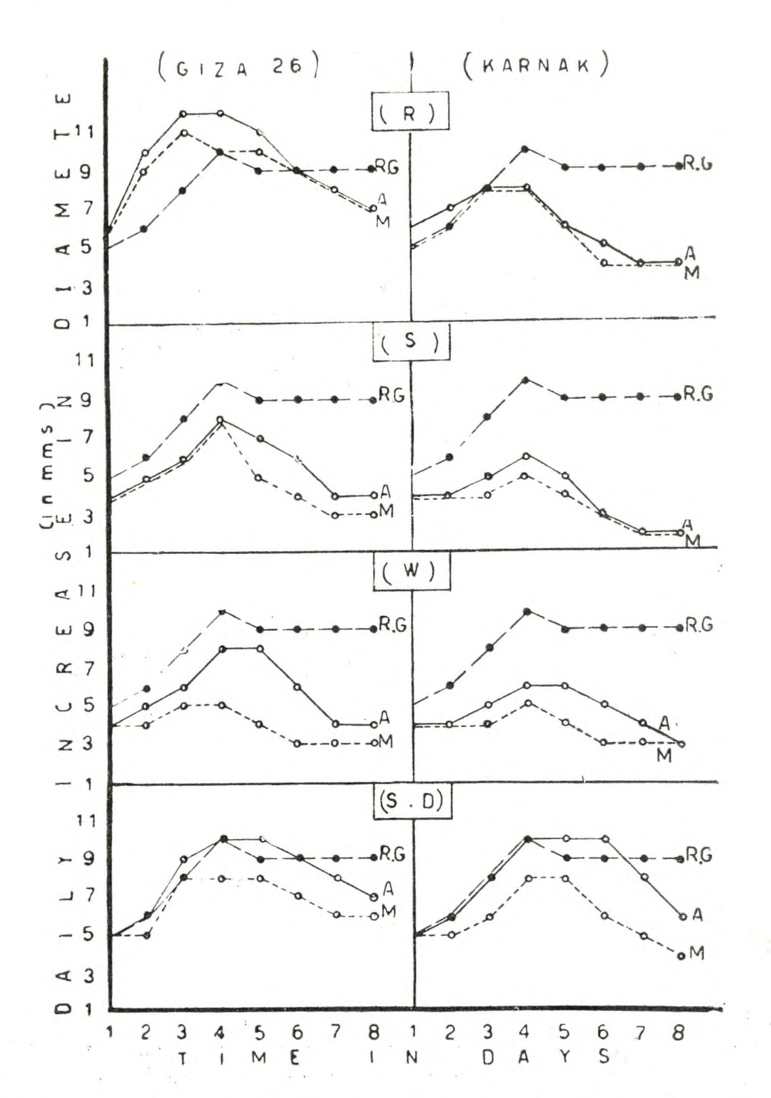


Fig. 5. — *Fusarium* growth-rate curves, at 25°C, on different treatments of seed extracts (S.D.), extracts from two-weeks old whole seedlings (W) as well as from their respective shoots (S) and roots (R). and on autoclaved Richard's solution agar (R.G.); each type of cotton extracts is applied either autoclaved (A) or cold-sterilized (M).

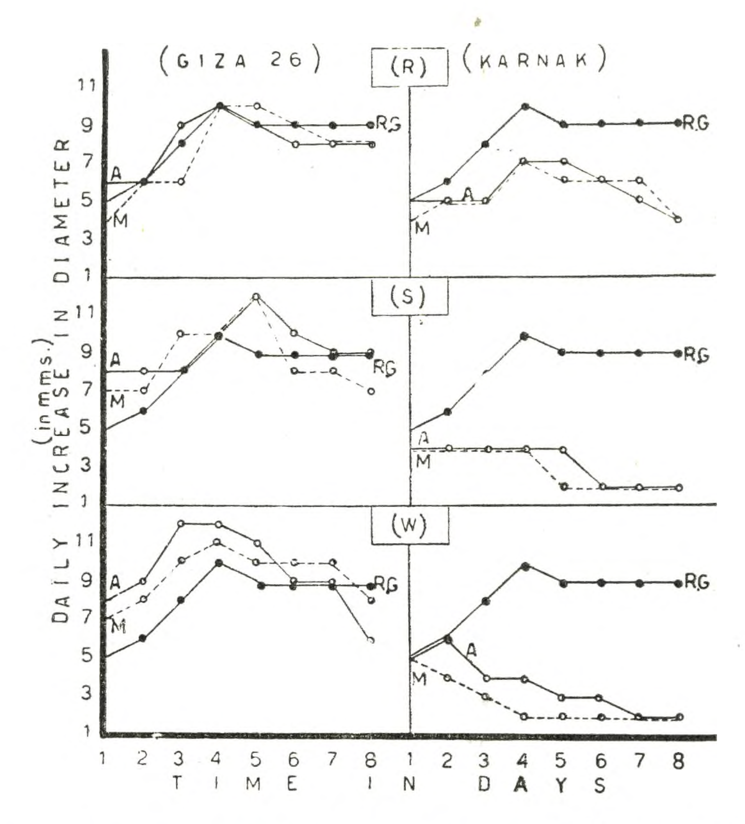


Fig. 6. — *Fusarium* growth-rate curves, at 25°C, on different treatments of extracts from four-weeks old whole seedlings (W) as well as from their respective shoots (S) and roots (R) and on autoclaved Richard's solution agar (R.G.); each type of cotton extract is applied either autoclaved (A) or cold-sterilized (M).

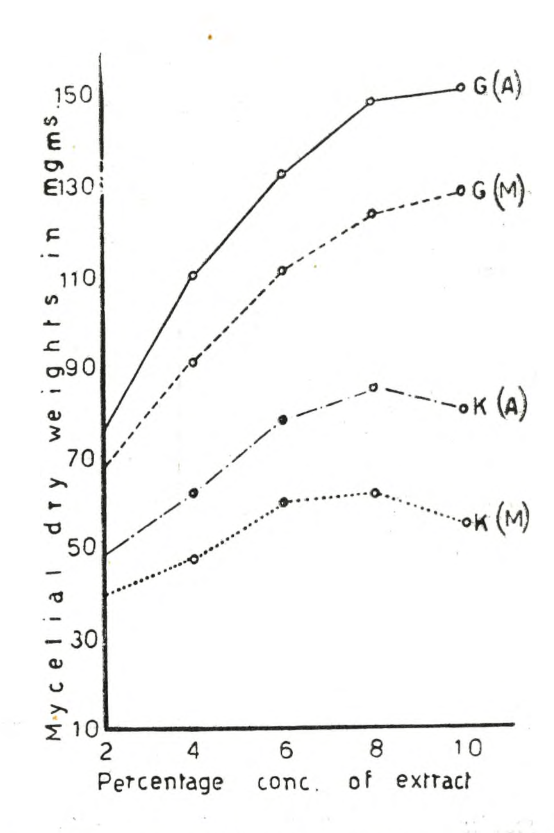


Fig. 7. — *Fusarium* mycelial dry weights, at 25°C, on varying concentrations of autoclaved (A) and cold-sterilized (M) extracts from "Giza 26" (G) and "Karnak" (K) seeds.

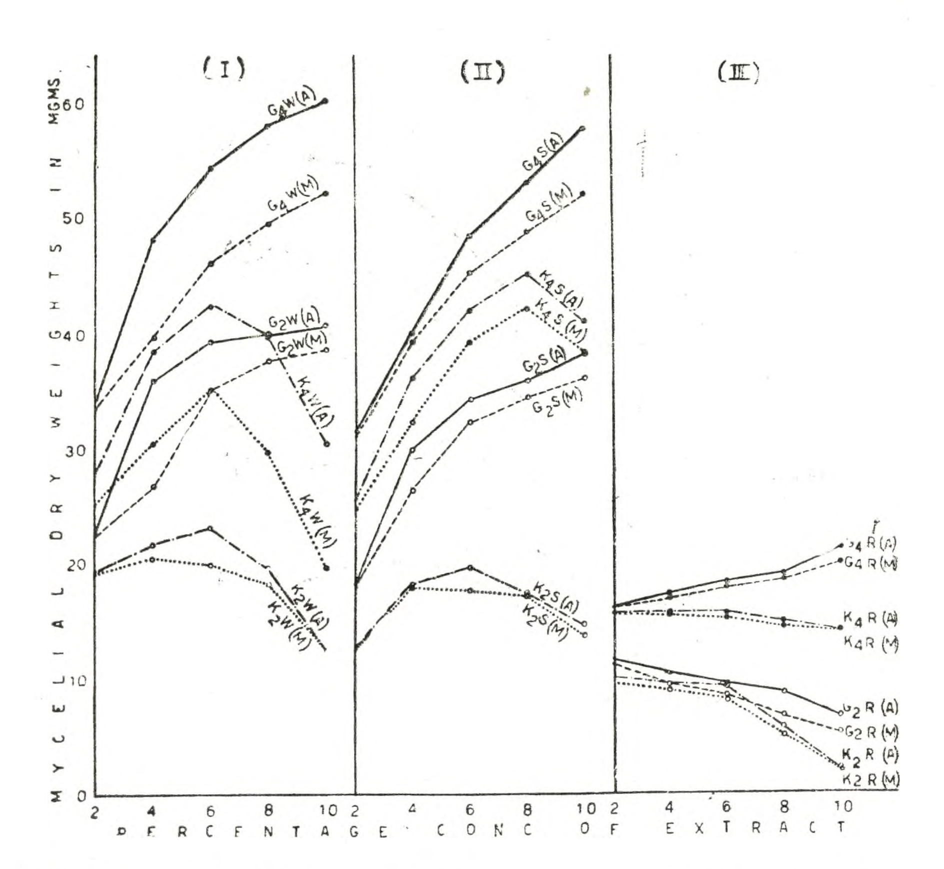
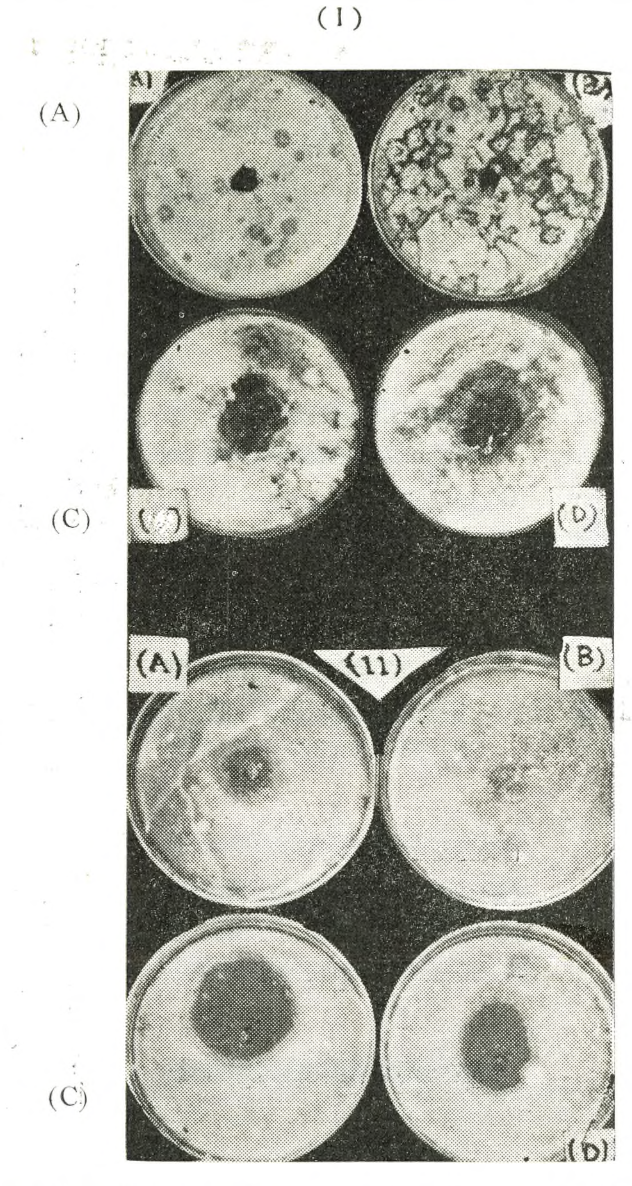


Fig. 8. — *Fusarium* mycelial dry weights, at 25°C, on varying concentrations of either autoclaved (A) or cold-sterilized (M) aqueous extracts from: (I) Two-weeks old seedlings of "Giza 26" (G.W) and "Karnak" (K.W) and corresponding four-weeks old seedlings (i.e. G_4W and K_4W), (II) Shoots of two-weeks i.e. G_2S and K_2S) and four-weeks (i.e. G_4S and K_4S) old seedlings, and (III) Roots from respective seedlings (i.e. G_2R K_2R, G_4R, and K_4R).

(I)

(A)



(C)

(C)

Fig. 9. — *Fusarium* experiments with 10% aqueous (I) or ether (II) extracts from: (A) "Giza 26" seedlings roots (B) "Giza 26" seedling shoots, (C) "Karnak" seedling roots, and (D) "Karnak" seedling shoots; all cultures are reduced to about 1/3 of original size.

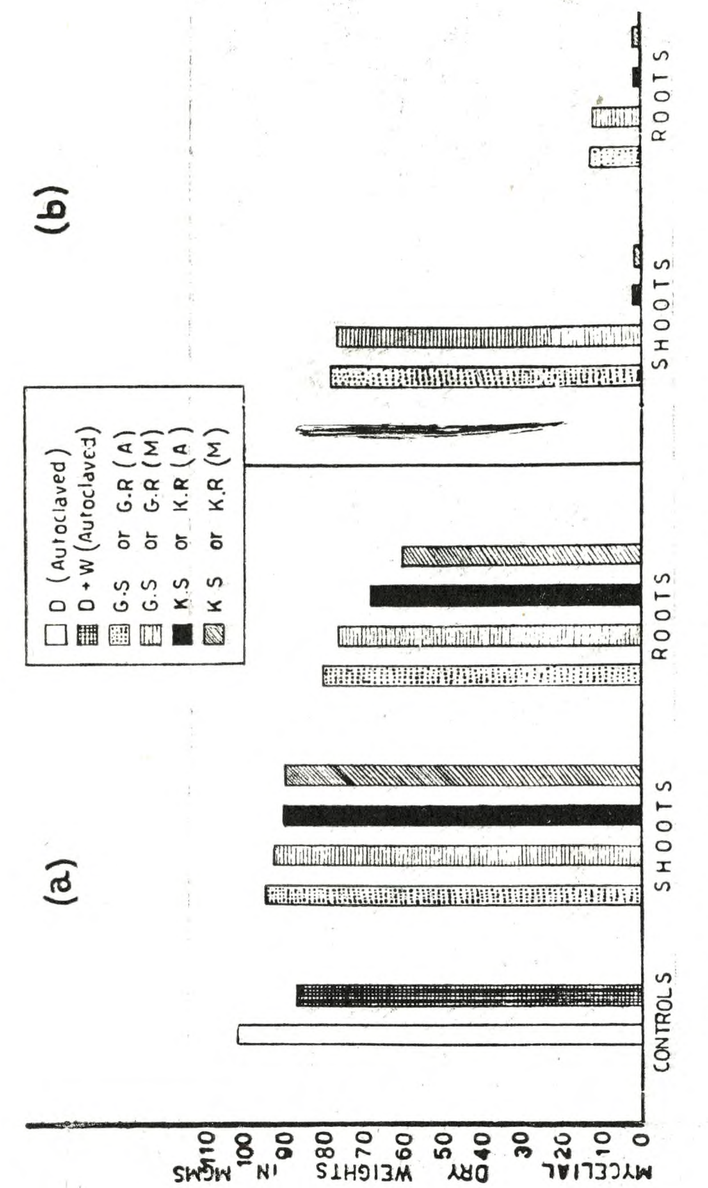


Fig.10. — *Fusarium* mycelial dry weights on different treatments of Dox's liquid to which is added either: (a) Aqueous extract or (b) ether extract, from two-weeks old seedling shoots(S) and roots (R) of either "Giza 26" (G) or "Karnak" (K); each extract is applied either autoclaved (A) or cold-sterilized (M). Dox's liquid is symbolized as (D) and Dox plus water as (D+W).

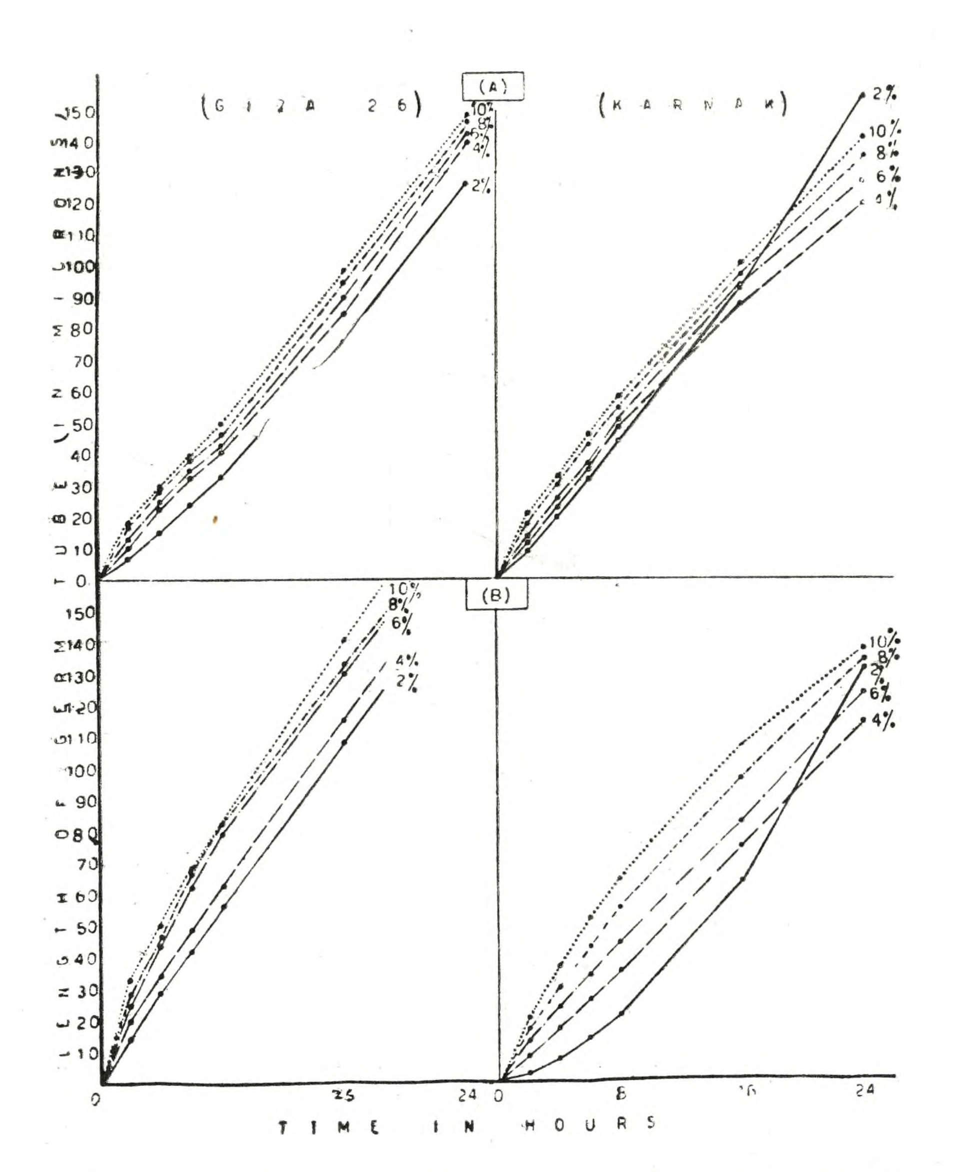


Fig.11. — Germ-tube elongation rate, of *Fusarium* microconidia (A) or macroconidia (B), on varying concentrations of aqueous extracts from "Giza 26" and "Karnak" seed extracts.

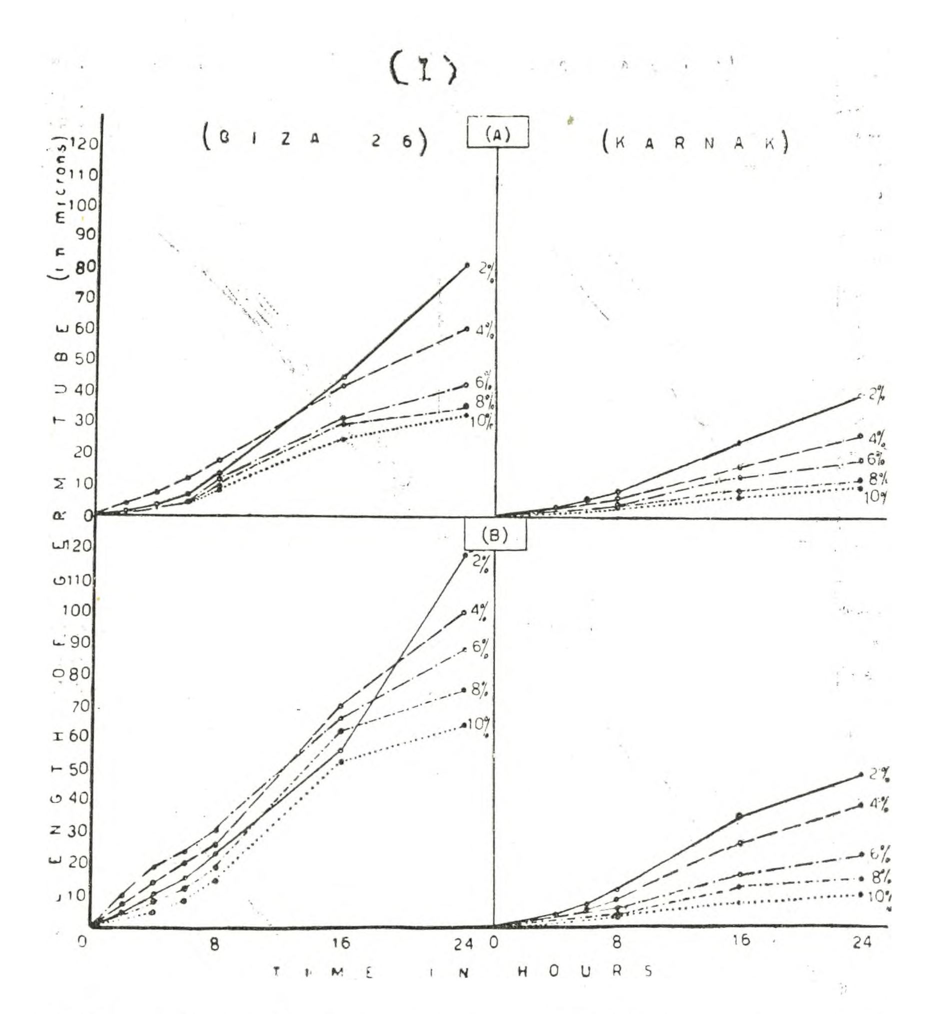
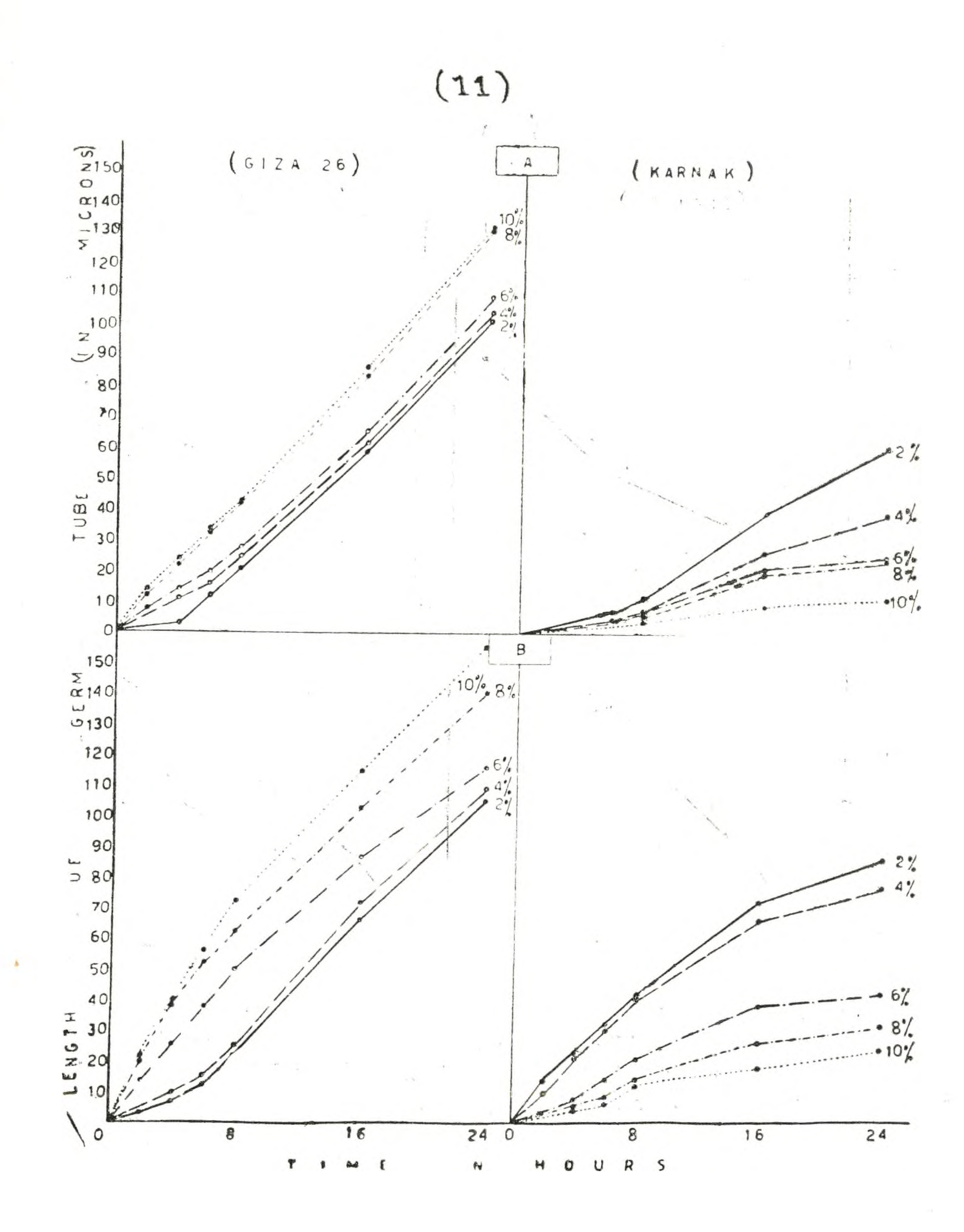


Fig.12. — Germ-tube elongation rate, of *Fusarium* microconidia (A) or macroconidia (B), on varying concentrations of aqueous extracts from "Giza 26" and "Karnak" seedling root (I) and shoot (II) extracts.



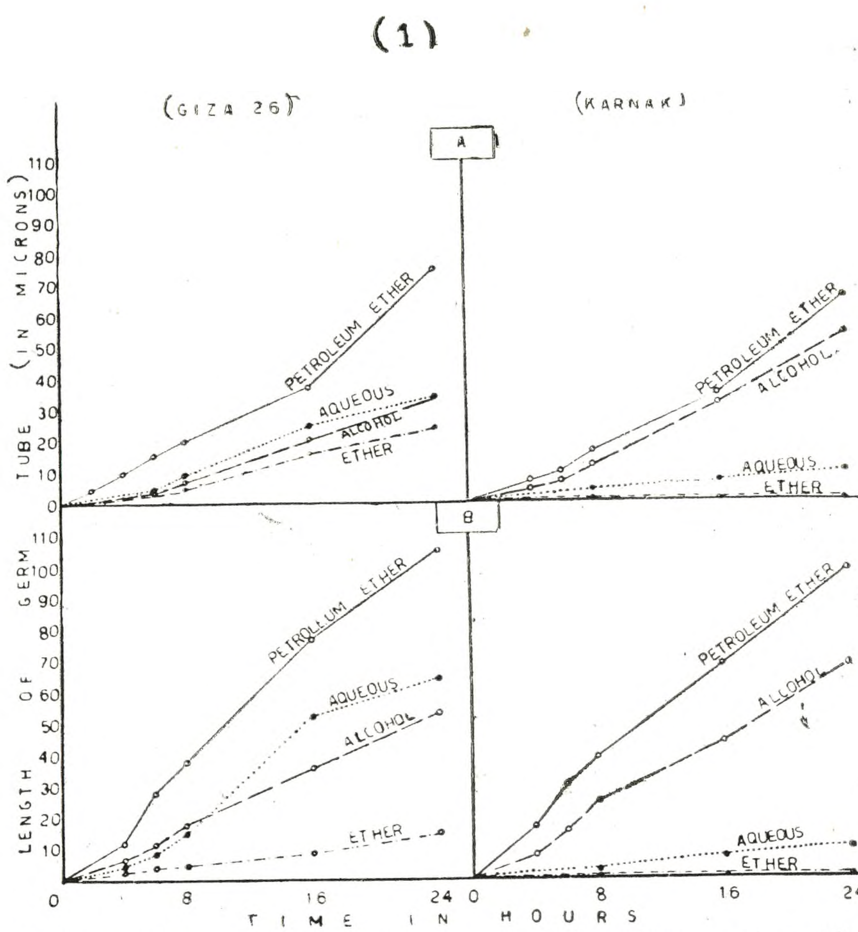
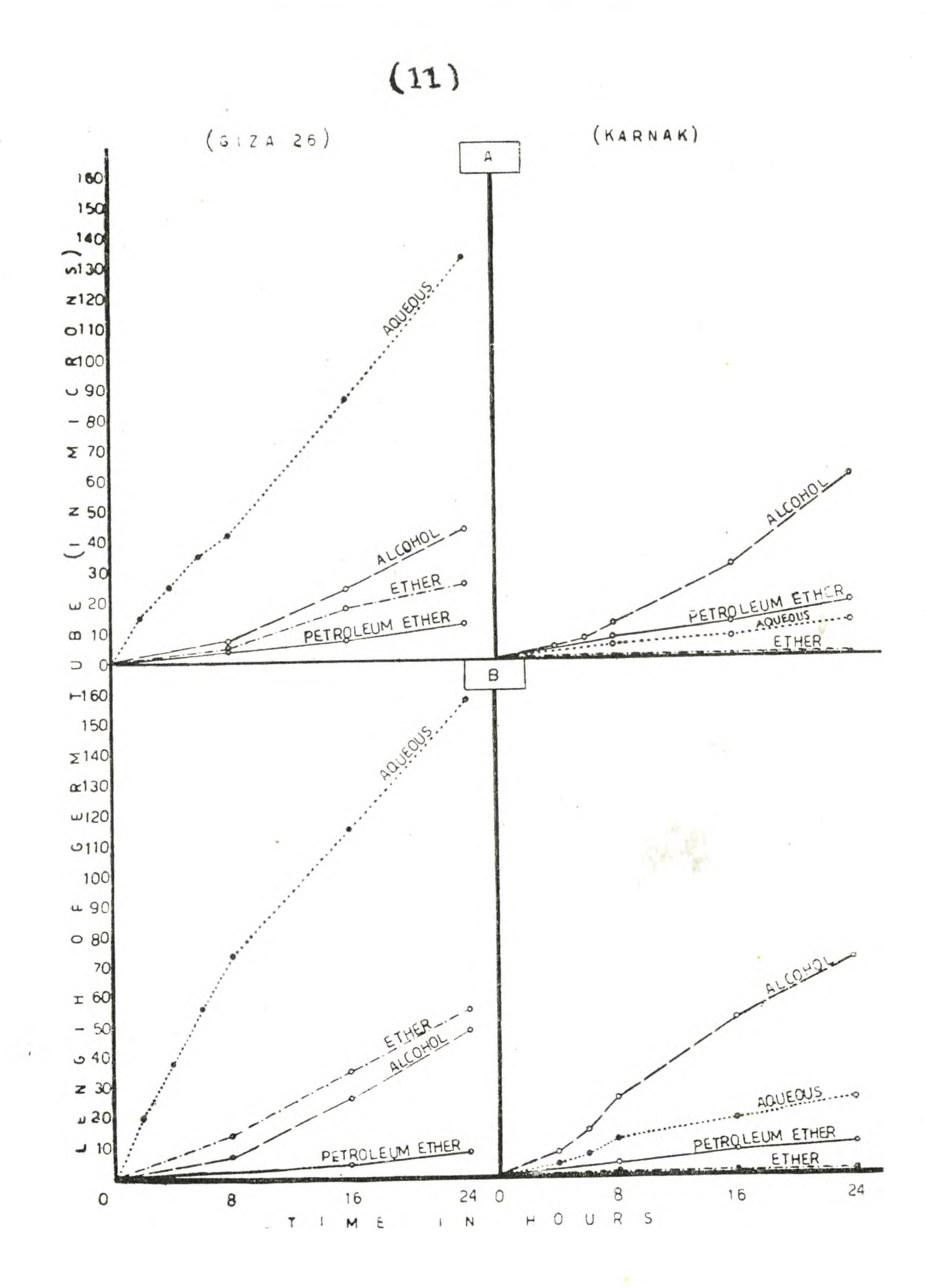


Fig.13. — Germ-tube elongation rate, of *Fusarium* microconidia (A) or macroconidia (B), in response to 10% concentration of differently treated extracts or "Giza 26" and "Karnak" seedling roots (I) or shoots (II).



THE IGNEOUS AND METAMORPHIC ROCKS OF THE AREA BETWEEN GEBEL ATSHAN AND GEBEL HAMADAT, NEAR QOSEIR, EASTERN DESERT OF EGYPT (1)

by

AMIN R. GINDY,
University of Alexandria

ABSTRACT

This communication deals with the petrography of a small sector (of about 50 sq. km.) of a wide terrain of old pre-Cambrian plateau lavas, mostly andesitic, cut by doleritic intrusions. These rocks were then orogenically deformed and were injected first by small quartz-diorite bodies and then by a granite boss which may represent a cupola among others that belong to a much larger subjacent intrusion.

The country rocks are in the greenschist facies except in the contact aureole of the granite where epidote-amphibolite and amphibolite facies are present. The variability in the character of the granite and the post-granitic hydrothermal activities are also described.

Dyke swarms of late minor intrusions cut all preceding rocks.

ACKNOWLEDGMENTS

The writer wishes to record his deep thanks to the Egyptian Phosphate Mining Company at Qoseir, particularly to Signor A. Laurenti, to Mr. Fouad el Shall and to their assistants at Atshan Mine for their kind hospitality. He is also grateful to his colleague Dr. Mourad I. Youssef for making available to him his large-scale topographic field-maps and for the information about

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(1) Communication présentée en séance de 5 Décembre 1955.

the post-Nubian sedimentary rocks incorporated in fig. 1. Mr. Ahmed Ezzat of Alexandria University has very kindly prepared the photographs in the plates.

I. — INTRODUCTION AND PREVIOUS LITERATURE

The phosphate-mining area near Qoseir has recently become a frequent centre for geological university excursions; the main interest has been so far in the stratigraphy and structure of the sedimentary rocks of the area but the older pre-Nubian Sandstone and pre-Cambrian rocks have hitherto received very limited attention and, as far as the present writer is aware, no detailed study had been carried or published on them. The writer therefore had felt the need to fill the gap in our knowledge of the older geology of that area and he hopes, as far as circumstances permit, to consider this geology in a series of communications covering different sectors of the Qoseir terrain.

This first communication deals with a sector of about fifty square kilometres roughly limited by longitudes 34° 8′ and 34° 14′ E. and latitudes 25° 59′ and 26° 5′ N. This area which is one of the most readily accessible and most frequented by university excursions, is shown in fig. 1. Original field mapping of the pre-Nubian sandstone rocks was made on topographical maps of a scale 1 : 50,000. Details of the post-Nubian rocks included in the figure are taken from Dr. M. I. Youssef's map (1949) of these rocks in a larger area.

Very little concrete or systematic description is mentioned about the older pre-Nubian rocks around Qoseir. What has been written on these rocks is mostly in the form of observations in the field recorded during few reconnaisance traverses, e.g. the regional works of Barron and Hume (1902), Hume (1907), Ball (1912), Hume et. alter. (1920) and Beadnell (1924). In the geological maps of Beadnell (1924, near northmost boundary of Plate I), and Hume (1934, Plate LXXVI) all the older rocks are given the same colour without any distinction of their included members.

As the present communication is concerned only with the pre-Nubian rocks, references to the physical geology of the Qoseir area should be made to the works quoted above or to M. I. Youssef's (1949) recent detailed study of the post-Nubian rocks of that area.

As no detailed study has yet been carried on corresponding rocks of areas adjacent to the present sector, no correlation or reference to the likely extension outside the present sector of the rock types identified here can be made with neighbouring areas, and in this paper all descriptions and conclusions come from rocks and evidence available within the confines of this sector of the Qoseir terrain. Consequently, the conclusions drawn here are strictly applicable to this sector but if applied to the larger Qoseir terrain they will certainly be subject to further details and modifications as other adjacent sectors of the terrain become studied in the future.

II. — SUMMARY OF THE PRE-NUBIAN GEOLOGICAL HISTORY

The geological events recorded in the pre-Nubian rocks of the present sector as deduced by the writer are as follows starting with the oldest and ending with the youngest events available in the sector:

1. Extrusion of huge bodies of plateau-like lavas, mostly of andesite with subordinate more acidic or more basic varieties.
2. Intrusion of dykes, sills, sheets, laccoliths etc. of dolerite, gabbro and kindred types.
3. Orogenic disturbances causing structural changes in the lava beds and associated intrusions; bedding and resulting schistosity strike roughly NNW-SSE.
4. Intrusion of small bodies of quartz-diorite, perhaps in the later phases of the orogeny or afterwards.
5. Intrusion of a large granite body, variable in detail; with a rare suite of aplite dykes.
6. Intrusion of quartz veins and dykes without or with a variable content of epidote, calcite, chlorite and sometimes pyrite. The quartz dykes distinctly strike NE-SW, along what was probably a pre-existing and easily opened joint system.
7. Intrusion of Igneous dark or red long dykes in swarms cutting all pre-existing rocks in a very roughly N-S direction along what was probably tensional jointing at this epoch.

III. — GENERAL CHARACTERISTICS OF THE COUNTRY ROCK

In the present area, the country rock of the large granite intrusion is generally made up of a thick mostly massive series of what was probably extensive old lava beds and igneous intrusions of variable composition and appearance. It is not possible, from the confines of the present area, to determine the geographic trend of this ancient volcanic belt but it is beyond doubt that we are dealing with a sector from a large and important terrain of andesite-basalt volcanic associations. The outer extension of this volcanic terrain lies beyond the limit of the present area and has to be sought after and determined in future detailed studies of neighbouring areas. In the Survey Memoirs, e.g. Baron and Hume (1912) and Hume (1934, 1935), there are scattered references about the occurrence of andesites, dacites etc. particularly north of latitude 26°, north of the present area. Similar volcanics seem also to extend southwards to the Sudan.

The original total thickness of these volcanics is probably measurable in thousands of metres. For example, the thickness of the volcanics west of Gebel Atshan in the present area, is in the range of 3000 metres and this would only represent part of the succession. However, great caution must be excercised in such estimates for the beds may be repeated by strong monoclinal foldings or by faultings but no proof for this exists in the present area and the beds are not distinctly different from each other so as to allow their correlation over different exposures.

Age problems and correlation of members of the country rock and their associated granites, veins etc. will be discussed in a separate paper (1).

Petrographic studies of the country rock are rendered rather difficult by the fact that these rocks have suffered several extensive alterations, "progressive" and retrogressive metamorphisms during lengthy periods of their history. Repeated shearings and hydrothermal activities along these shear belts did much to obscure the original identity of some of the sheared

(1) Paper dealing with a larger area to be read before the Third Arab Science Congress, Beirut, September 1957.

rocks. Thus within the present area, there is no decisive proof of the original occurrence of tuff and ash-beds or other pyroclastics of fine to medium grain ; nor is there any good indications of the presence of distinct greywackes and other sedimentary beds. It thus cannot be said with certainty whether the vulcanism here was intermittent or continuous ; probably the latter. While fine tuffs or ash beds are suspected in certain places, no coarse agglomerates, conglomerates or breccias were observed in the present area ; and if the volcanic activities were intermittent, the evidence from this area would not be in favour of long intervening periods of erosion (2).

Except for the conspicuously porphyritic andesites and the dark green amphibolites (metabasalts and metadolerites), it is frequently rather difficult in the field to distinguish clearly between the different kinds of country rock present. Indeed some of these present quite a misleading appearance. For example, some of the extensively sheared and leached andesites and dacites (as determined from thin section) appear like pale or creamy coloured and banded psammites, semipelites or flagstones and weather in a papery manner. In other cases, the shearing is so strong that the original nature of the rock under the microscope is lost.

The general impression is that in this area we have a complex volcanic suite which, apart from the doubtful tuff beds and sediments, consists largely of porphyritic andesite lavas alternating with variants of andesite-basalts, basalts and dacites and the whole suite are cut by doleritic sheets, dykes and laccoliths or bulbous thick intrusions. As it is not possible to determine clearly the order of eruption of the different lavas, no correlation between the chemical composition and order of eruption can be made. Probably, however, such a relation did not exist and eruptions of different compositions alternated without definite order as have been recently observed in some

(2) Coarse agglomerates, breccias and conglomerates as well as sediments intercalating the thick andesitic series were all discovered later in the larger area, to the west of the present sector. The bedded iron ores of Wadi Kareim and the ferruginous conglomerates and breccias might represent in part original weathered products from these volcanic rocks and from ultrabasic and basic igneous rocks.

andesitic volcanic associations (e.g. see Turner and Verhoogen, 1951, pp. 212-224).

Tectonics and structure of the country rock: From fig. 1 it can be seen that the general bedded succession of the country rock strikes in a NNW-SSE direction and generally with high dips (between 70° - 80°) to the SWW. This is true for the country rock west and opposite Gebel Atshan but at its portion just opposite the southern end of Gebel Atshan there appears to be a tight fold as the direction of dip briskly changes. Strong contortion is observed in certain localities especially in the western part of the area. Steep isoclinal folds are, as said before, very doubtful and improbable. The general trend of strong shearing and shear belts is similar to that of the strike of bedding.

In the country rock southeast of Gebel Atshan, whenever determinable, the structural trend becomes somewhat shifted to NW - SE and is apparently parallel to the border of the granite boss there as if the latter had shouldered and pushed the country rock there. Later block faulting may also have contributed to this small change in trend.

In the field, strong foliation is only seen along shear lines or belts at the contacts between the different members or in the easily affected members between more massive ones and it is intresting to note that the very late hydrothermal pyrite cubes are conspicuously formed in the country rock in such sheared zones as they afford the best planes of easy accessibility for hydrothermal solutions. Some of the massive andesites and dolerites show in handspecimen no foliation or schistosity at all while others can be easily cleaved by the hammer into pencil-like straight rods. Indeed, good foliation as exemplified by the perfect parallel growth of flaky or prismatic minerals is not typically seen in the present area. This may be due to the general very low grade of metamorphism of the rocks as well as to the original largely massive nature of these igneous rocks. As will be seen from the petrography of the country rock, these rocks are mainly in the greenschist facies (corresponding to the chlorite zone) except in the contact aureole of the granite where mineral assemblages of the epidote-amphibolite and amphibolite facies are found (equivalent to biotite, garnet and other high grades of regional metamorphism or medium grades of contact metamorphism). The production of retrogresive chlorite in abundance might obscure any weak schistosity that had existed in such rocks.

As Schürmann (1953) had recently shown in the northern part of the Eastern Desert, the structural trend of the country rock here also corresponds to that of the young folded sedimentary rocks overlying them.

In the following pages the rocks of the area are dealt with in their chronological order (as given earlier) starting with those of the country rock : the meta-andesites and metadolerites. Each of the latter is considered under two divisions : outside and inside the contact aureole of the granite. Original varieties of the common meta-andesites and metadolerites are mentioned in appropriate places within the petrography of each rock.

IV. — METAMORPHISM OF THE META-ANDESITES AND RELATED ROCKS

The meta-andesites in handspecimens are massive, very fine grained with a dull looking greenish grey matrix in which occur white (sometimes reddish or yellowish because of hematite or limonite dust) porphyritic plagioclases. These phenocrysts lack lustre and are of all dimensions below 1 cm. (fig. 4). Many of them are of euhedral outline and are sometimes crudely arranged in a subparallel manner suggesting an original flow effect. In the porphyritic meta-andesites, the average modal percentage of the phenocrysts of plagioclase with their longest diameter above 1 mm. is roughly about 19% by volume (average of 14 determinations); the extremes being 30% and 13%. The fourteen specimens selected were the least sheared and were collected from all over the area irrespective of their metamorphic "grade". It has been found that the meta-andesites of the sector SE. of Gebel Atshan have generally a higher modal original porphyritic plagioclase than the corresponding rocks of the western half of the area, though these determinations are probably below the actual original values as some of the smaller porphyritic crystals may be lost through alteration or are below the 1 mm. limit.

The sheared varieties can be easily broken into long or flat slabs or, as is common, the whole rock is intensely sheared and

drawn into irregular subparallel small lensoid fragments weakly cemented together by quartz or calcite veins. The sheared rocks are often of paler colour than the less sheared ones or they may be irregularly tinted pink or red through the alteration of their iron ingredients, particularly the late hydrothermal pyrite, into hematite. Rarely, they are tinted green because of malachitic stains; probably alterations after any late hydrothermal copper sulphides.

A. General petrography of the meta-andesites outside the contact aureole of the granite:

The commonest mineral assemblages observed in thin sections comprise two or more of the following minerals:

Albite or albitic oligoclase, chlorite, white sericite-like mica, calcite and quartz with rare or without epidote. Such assemblages point at once to a low grade of metamorphism.

Plagioclase in large phenocrysts, in many cases still retaining their euhedral outline (figs. 3 & 4), occurs in different degrees of alteration in different specimens. It may be variably replaced by sericite, kaolin (opaque dust, white in reflected light), calcite and may be sieved by tiny quartz and chlorite. This chlorite as well as some other material in the altered plagioclase are due to migration of alteration products from pre-existing adjacent ferro-magnesian minerals or from the matrix. Sometimes, plagioclase is altered more in certain zones than in the others denoting an original zoning, and an outer less altered but more albitic zone may be present. The outline of the plagioclase is sometimes rounded and may indicate an original partial resorption while in others phenocrysts show through the alterations several oscillatory zones which are probably original but the outer albitic clear mantles are probably of metamorphic origin. Beside the phenocrysts, smaller lath shaped plagioclase felspars (sometimes with fairly well developed subparallel flow arrangement) may occasionally be preserved in the matrix. In some sheared andesites, the plagioclase phenocrysts are bent or fractured and in extreme cases, along shear zones, they are entirely destroyed. Some of the large pehnocrysts may show indications of fracture during the original flow of the lava as the matrix between the phenocrysts does not show any corresponding shears. Beside

the tiny laths, plagioclase occurs in the matrix in a very fine grained mosaic (average grain diameter below 0.07 mm.) together with quartz, chlorite and sericite. In some cases the mosaic is so fine that it is difficult to distinguish its constituent minerals, and may represent the products of devitrification of orginal glassy or cryptocrystalline matrices between the phenocrysts.

Beside the large plagioclase phenocrysts, there are also large dark green areas occupied by aggregates of pale green chlorite, calcite and much subordinate epidote in variable amounts in different specimens. In few cases do these aggregates retain a regular outer outline suggesting pseudomorphs of ferromagnesian phenocrysts but more commonly their outline is in the form of roughly subparallel lenses (lengths up 1 cm.). These lenses are probably due to drawing by shear of the original pre-existing ferromagnesian phenocrysts and from their sheared material, the present chlorite-calcite aggregates were then formed (fig. 3). Tiny roughly subparallel *chlorite* flakes (length below 0.1 mm.) also occur traversing the fine mosaic between the plagioclase phenocrysts and ferromagnesian knots, but more often because of the late hydrothermal activities these chlorites as well as those of the large aggregates occur in the form of tiny radiating tufts without any orientation. In general, chlorites outside the contact aureole show in thin section a pale green washed colour and are of very low birefringence, almost isotropic under crossed nicols without any abnormal polarisation colours. In all observed cases, except one, they are optically positive. *Calcite* (and probably other kinds of carbonate) is quite common in such rocks and characteristically occurs as tiny irregular amœboid or shredded grains in the matrix or in larger grains in the chloritic knots, sometimes almost replacing them and still preserving their outline. Some carbonate grains absorb stains of iron oxide and appear brownish.

Epidote (epidote proper or clinozoisite) is either conspicuously absent or present only in very tiny granules especially in the ferromagnesian aggregates. It is never as frequent here as in varieties of the contact aureole; probably because the metamorphic temperatures here rarely attained degrees favourable for epidote production.

Tiny colourless flakes of mica (average length 0.05 mm.)

occur in variable amounts in the fine matrix as well as the plagioclase phenocrysts. They are simply referred to here as *sericite* but some may be of paragonite or colourless clay minerals. Occasionally the sericite flakes become roughly oriented in two sets crossing each other and at the same time diagonal to the general trend of any foliation or schistosity present and may represent late hydrothermal flakes that have formed along s-planes. Sericite flakes may also traverse the coarse chlorite tufts.

Other minerals observed are occasional apatite, tiny sphenes, ilmenite, sometimes leucoxenic, limonite, hematite and amorphous clay particles; prehnite and zeolite minerals are also suspected in some varieties.

The typical mineral association of the meta-andesites is thus albite-quartz-chlorite-calcite-sericite and is characteristic of the greenschist facies.

In a vague and doubtful case, rounded structures filled by tiny granular quartz and wrapped from outside by sheaves of chlorite simulate the pre-existence of amygdaloidal structures.

Quartz, calcite, epidote and rare tourmaline-quartz veins traverse these rocks and are mentioned later with hydrothermal activities, as shearing and hydrothermal activities must have occurred in several different episodes during the history of these rocks. In extensively sheared meta-andesites, typical quartz-sericite-chlorite-calcite *schists* are formed and all pre-existing features of the rock are obliterated. In such rocks the shear and schistosity planes help hydrothermal solutions to travel along them and leach much of the chlorite so that the rock becomes of a buff white colour. Late idiomorphic pyrite cubes deposited from such solutions are better and more developed in such sheared rocks than elsewhere (3).

The Tuffs: Although these rocks resemble the meta-andesites in mineralogy, they differ from them in having a rather irregular and heterogeneous texture and mineral distribution. Some are relatively poor in chlorite and are thus of buff light colour. In thin section, some patches represent much altered andesite particles (with ghosts of pre-existing plagioclase phenocrysts in a felsitic mosaic) while in other patches of the same slide large grains of quartz (apparently not vein quartz) are of dimensions much beyond those frequent in the meta-andesites. In the field, foliation and shear features are usually displayed best in such rocks but once this is intense no distinction can be drawn between the meta-andesites and tuffs. Actually, the original presenc of tuffs and related sediments in the present sector cannot be definitely established. Coarse pyroclastics or agglomerates are absent.

(3) The iron leached from the chlorites etc. may be utilized at the same time for the production of pyrite.

The Dacites: Some massive and pale yellowish fine grained specimens showed in thin section a more acidic nature than that of andesites. They seem to represent pre-existing dacites. Prophyritic crystals of both albite and euhedral or resorbed quartz occur in the matrix (fig. 7). This quartz is definitely different in habit, size and shape of any hydrothermal or vein quartz. Chlorite is scarce and the fine quartzo-felspathic matrix is spangled by tiny radiating sericite flakes.

Metadacites appear to be quite subordinate in amount to the meta-andesites and most probably represent more acidic original differentiates from the andesitic magma while appreciable increase of chlorite, calcite, leucoxene, sphene etc. in the usual meta-andesites indicate more basic varieties and link them to the basalts.

B. Petrography of the meta-andesites in the contact-aureole:

The width of the contact aureole is about a kilometre on the western border of the granite boss and is double that distance at the northern border as measured from the main outcrop of the large granite. The aureole becomes much wider to the east so that the country rock up to the southern tip of Gebel Atshan displays signs of high "grade". This may indicate the presence of an unexposed granite, probably an extension of the exposed one, underlying the country rock there at no great depths (fig. 2, fig 2A). Rocks in the contact aureole show different features from those outside it. Thus the meta-andesites there have matrix mosaics (quartz and acid plagioclase) of relatively coarser grain than before so that the average diameter may exceed 0.1 mm. especially in country rocks adjacent to the border of the granite. At the same time the mosaic becomes more sutured and thin sections as a whole become clearer and

not so much clouded as before. This is due to the gradual decrease and disappearance of tiny grains of calcite, chlorite, sericite, ore granules etc. *Biotite* of olive green or red brown (hornfels) colour as well as *hornblende* and *clinozoisite* are formed in variable proportions in the different specimens; most probably on account of the diminishing chlorite, calcite etc. that might have originally resulted from the shearing and "retrogressive" metamorphism of the andesites prior to their contact metamorphism. This is further proved by the fact that the large newly formed biotite and hornblende crystals are clearly concentrated in a decussate manner within the dark ferromagnesian knots which outside the aureole are occupied by chlorite aggregates. Sometimes the outer shape of such knots is still preserved. Some material or ingredients from the plagioclase must have also gone to the building of hornblende, clinozoisite and biotite (cf. Harker, 1939, pp. 282-3).

Biotite is usually of two dimensions; the larger (1.5 mm. long) and thicker flakes just mentioned and the smaller flakes traversing the matrix in a very crude subparallel manner (fig. 5). This arrangement is probably not as much due to directed pressure during their formation than to a mimetic habit provided by pre-existing schistose or shear planes offering planes of least resistance to the growth of the flakes. This is proved by the fact that the large decussate flakes in the ferromagnesian knots do not usually show such parallelism. At direct contact with the granite, all the biotite flakes become decussate. Pleochroic dark haloes are frequent in the biotite. Biotite to the exclusion of hornblende may occur in only few cases.

Hornblende occurs both in the matrix and the ferromagnesian knots. In the outer parts of the aureole it is rather actinolitic or tremolitic with small extinction angles when compared with that in meta-andesites near the granite. Hornblende in prisms up to 1.5 mm. long is pleochroic usually with Z deep bluish green, Y grass green and X pale yellow or green. In the matrix hornblende usually occurs in highly sieved poikiloblastic plates of paler colour in the interior than the outer borders of the plates. Clinozoisite is either in poikiloblastic plates or in well defined tiny crystals distributed all over the matrix and is rather distinct from the late retrogressive or hydrothermal deep green epidote.

Plagioclase becomes decidedly more basic than before. It is either albitic oligoclase or more commonly intermediate oligoclase $Ab_{80}An_{20}$. The outline of the large porphyritic crystals is still preserved in variable degrees. Where not hydrothermally altered the plagioclase becomes clear and homogeneous without trace of oscillatory zoning. Even the albite lamellar twinning becomes feeble or absent. However, the plagioclase becomes riddled with small well defined crystals of biotite, hornblende, clinozoisite and grains of quartz, sphene and apatite. In some cases these are so numerous that they swamp the host plagioclase whose outline shows only under crossed nicols as faint ghost sieved by the other mineral granules (fig. 6). The latter must have formed at least in part from the chloritic, calcitic, iron ingredients etc. that had previously migrated into the plagioclase, perhaps along its cleavage prior to their present metamorphism. No large new plagioclase porphyroblasts are formed, only the old porphyritic ones, sometimes perhaps with new thin outer rims are found.

As regards the accessory minerals, notable changes occur in the iron opaques. They are seen in all stages changing to sphene; in intermediate stages the opaque cores are surrounded by botroyoidal whitish growth of leucoxene. Apatite becomes quite frequent in all meta-andesites of the aureole. Tourmaline, pleochroic in bluish and violet colours is found in a spot 2 km. southeast of the southern tip of Gebel Atshan, but it may be related to the late hydrothermal tourmaline-quartz veins that traverse the rock there and from which it must have diffused.

In only very few examples particularly in the vicinity of the contact with the granite at its western border, definite *microcline* has been found. It is in the form of very tiny granules and intergranular films particularly replacing the plagioclase. Its total amount is quite small but the rock may acquire a pinkish tinge and looks like a fine grained dark granite. It will thus be noticed that apart from the small introductions in boric and alkali ingredients, there is on the whole no pronounced variation in the total chemical composition of the rocks inside or outside the aureole and no signs of any granitising effects are present. In the rare cases at the contact where microcline is formed, its amount is so small that the rock can hardly be described as felspathised.

The typical mineral association of meta-andesites in the contact aureole is thus: *quartz-oligoclase-hornblende-biotite-clinozoisite-sphene* indicating assemblages equivalent to the epidote-amphibolite and amphibolite facies.

Basic varieties of the meta-andesites of this aureole are indicated by the impressive increase in the proportion of hornblende and biotite (metabasalts and metadolerites) while the reverse holds for acidic (metadacitic) varieties with occasional large quartzitic areas. Retrogressive features, mainly due to late post-granitic hydrothermal stages of alteration, are not usually very pronounced in the rocks of the aureole except in certain localities. Such features include the production of epidote, sericitisation of oligoclase, chloritisation and prehnitisation of biotite and hornblende with release of ore granules, pyritisation, calcitisation and even some silicification. Chlorite pseudomorphs after biotite are decidedly much different from the chlorites outside the aureole. Here, the chlorite is deep green, strongly pleochroic pennenite with abnormal interference colours. Large and broad hydrothermal muscovite flakes in porphyroblastic habit may form and replace the quartzo-felspathic matrix but they particularly attack the large oligoclase plates in some localities adjacent to the granite (especially the yellow granite) and are probably directly related to hydrothermal solutions conveyed by the latter.

The retrogressive hydrothermal alterations had unfortunately attacked a strikingly spotted rock near the contact of the granite in the southeastern side of the map-area. The "spots" are large and elongated (up to 1 cm. long) of dark green colour, simulating crystalline outlines and are set haphazardly in a whitish very fine quartzo-felspathic matrix (fig. 8). Under the microscope, the dark "spots" are now pseudomorphed by a dense mess of tiny chlorites and much more sericite flakes in shimmer aggregates. Not a trace of the pre-existing mineral survives though it must have occupied about 34% by volume of the rock. It thus cannot be known what metamorphic mineral had formed there or whether the rock might have even represented a rare variety of the igneous country rock that had such an appearance prior to its metamorphism.

V. — METAMORPHISM OF THE METADOLERITES AND RELATED ROCKS

As said earlier the metadolerites represent basic dolerite intrusions into the andesites and associated rocks. In the field, they give the hills a dark greenish hue and because of their superior resistance to weathering they appear sometimes as capping the hills.

The orogenic deformations had strongly sheared many of these ancient intrusions, especially the smaller ones and sometimes had boudinaged and drawn them into lensoid bodies.

The metadolerites are fine-grained except in larger intrusions which are coarser. They are usually massive unless extensively sheared in which case their dark greenish colour becomes paler, probably because of the leaching of part of their ferromagnesian content and the pronounced development of hydrothermal calcite. As in the meta-andesites, hydrothermal pyrites are frequent in the scheared metadolerites. In composition and texture the metadolerites appear to have varied from true dolerites with typical and uniform doleritic texture to dolerites and basalts with porphyritic plagioclase linking them originally with the andesites. Coarser gabbroic varieties had also originally occurred in the thicker intrusions but dolerites were the commonst type. For brevity, all these varieties are referred to here as metadolerites; the metabasalts and metagabbros being included in the general term metadolerite.

As in the meta-andesites, the metadolerites are considered under two divisions; those regionally metamorphosed outside the contact aureole of the granite and those inside it.

A. Regional metadolerites outside the contact aureole:

Mineralogy: In thin section, the most common varieties show very fine grained and uniform ill defined irregular aggregates of greenish chlorite lamellæ and wisps. The chlorite is almost isotropic under crossed nicols and without abnormal polarisation colours. Length of flakes and lamellæ is below 0.1 mm. Between these chlorite lamellæ occurs a very fine, inconspicuous granular mosaic of felspar and quartz with perhaps rare and doubtful granules of clinozoisite. As far as can be determined, the plagioclase appears to be albite but it is definitely

not more basic than acid oligoclase. Apart from the late hydrothermal pyrite crystals, opaques probably in the form of magnetite, ilmenite or titaniferous magnetite are prominent in tiny spindles, lenses, needles or plates of haphazard orientation (fig. 9). Carbonates in large irregular and shredded plates are quite common. Apatite in tiny granules is frequent in some varieties and late tiny sericite flakes roughly trending in two directions diagonal to any weak foliation (especially in the coarser patches) may be present. Sericite flakes dissect and cut the chlorite lamellæ. Casual large hydrothermal grains of quartz may also occur.

The typical metamorphic mineral assemblage of the regional metadolerites is thus : *chlorite, albite, calcite, opaques* and *quartz.*

Textures and structures : In such low grade "retrogressive" metadolerites hardly any original textures or structures are preserved or can easily be ascertained in the fine chlorite-calcite-plagioclase-quartz aggregates. However, sometimes when thin sections are viewed by reflected light under low or medium magnification, evidence of the pre-existing doleritic or subophitic textures may be detected ; the position of the original plagioclase laths being indicated by clouded tiny knots of "dust" that appear white by reflected light. In such cases, it may be seen that some of the opaque spindles and needles occur along the boundaries of pre-existing plagioclase and ferromagnesian minerals or along cleavages of the latter denoting the release of opaque residues as a consequence of chloritisation and saussuritisation of the dolerites. In some varieties with relict subophitic texture, intergranular quartz is found apparently moulded in the spaces between the original adjacent plagioclase laths and the original rocks might have been quartz-dolerites. Metadolerites and metabasalts with porphyritic plagioclase crystals usually have that texture well preserved. Though many of the hand-specimens are obviously sheared, crude foliation is seen, especially under low magnification, in only a small number of thin sections particularly those with an even texture.

B. Metadolerites of the contact aureole:

1. *Metadolerites in the outer part of the contact aureole :* In the outer part of the contact aureole, the following changes usually occur in variable degrees. The opaques change gradually

to sphene or leucoxene ; the plagioclase becomes slightly more basic, calcite dwindles while clinozoisite and actinolitic amphibole start to develop abundantly. The grain size becomes relatively coarser than before.

A typical example comes from the metadolerite dykes few yards southwest of the disused quarry pit by the motor track opposite the conspicuous Red Hill. Its mineral assemblage consists of *amphiboles, clinozoisite, sphene* and *plagioclase* (figs. 10 and 11). Sphenes in conspicuously large plates (about 0.6 mm. wide) and needles form 12% of the mode of the rock. Only some grains of them still have relics of the opaques remaining as nuclei inside the sphenes. Apart from the tiny clinozoisite granules present in the saussurite, the larger colourless ones dessiminated throughout the slide form by themselves about 8.5% of the mode of the rock. Amphiboles develop in the matrix in highly shredded aggregates of subparallel needles (fig. 11) but some may unite and build large highly sieved plates (up to 1.2 mm. long). The amphibole is actinolitic ($Z \wedge c$ about 15°) and is pleochroic from pale green to pale yellow or colourless. Almost isotropic chlorite wisps occur in the matrix with tiny granular aggregates of plagioclase. The latter seem to describe the outline of the original much larger plagioclase laths. Very rare and tiny olive green biotite flakes occur particularly in association with the amphiboles. Tiny veins of green epidote different from the clinozoisite of the rock belong to the late post-granitic vein-suites mentioned later.

2. *Metadolerites of the inner contact aureole and border xenoliths in the granite :* The mineralogical changes observed here are in continuation with those recorded in the outer aureole. Here, all pre-existing chlorite and calcite disappear, and hornblende and plagioclase with or without biotite are extensively formed all over the rocks. No conversion of hornblende or other ferromagnesians to pyroxene was observed, even in metadolerite xenoliths in the granite so that P/T conditions of the granulite facies were never attained here. Recrystallised plagioclase becomes clear and is often with weak oscillatory zones. Apatite in small needles is very frequent in all specimens. Sphene and epidote granules are variable in frequency but the latter is not important as before. Quartz in tiny or large granules is accessory but becomes quite rare in some varieties at the immediate

contact with the granite. Opaques, if not already changed to sphene, are present in accessory small granules probably of magnetite.

The fabric of the rocks in the inner aureole is diverse depending upon original textures and pre-granitic deformations. Most remarkable of the new fabrics is what appears like regeneration of the old pre-existing doleritic and subophitic textures of some of the metadolerites (figs. 12 and 13), though they are hardly noticeable in metadolerites outside the contact aureole. The new plagioclase laths (up to 1 mm. long) are clear and with fairly well defined outline. They are usually with mild oscillatory zones.

In the coarser metadolerites and metagabbros, the subophitic texture appears also to be regenerated but the plagioclase laths are no longer made of one crystal but of newly recrystallised clear aggregates of tiny granules of plagioclase keeping within the boundaries or outlines of the pre-existing large plagioclase laths and plates. In other metadolerites, evidence of pre-existing shearing is sometimes indicated by the mimetic recrystallisation and concentration of the newly formed ferromagnesian minerals into subparallel nodules along the former pre-existing shear planes as well as in dense knots in place of any deformed pre-existing porphyritic crystals of pyroxene (?). In such knots, hornblende with or without biotite occurs in decussate prisms and both minerals are relatively much coarser than those of the matrix and the latter in turn are larger than the hornblende and biotite that have formed inside the large pre-existing plagioclase plates.

Metadolerites with original subophitic or doleritic textures interrupted by large plagioclase or "pyribole" phenocrysts (suggesting a pre-existing porphyritic dolerite) may have their textures "regenerated". The same may occur in some of the porphyritic meta-basalts of this aureole. The matrix of the latter is usually made of clear granular mosaic or basic plagioclase with subordinate quartz. The average diameter of this mosaic is variable even in different parts of the same thin section. In one case of a metabasalt at direct contact with the granite, quartz is very scarce and the zoned plagioclase becomes as basic as basic andesine or acid labradorite. This is the most basic composition for a plagioclase recorded from this area ; the usual composition

of plagioclase of metadolerites of this zone being intermediate to basic oligoclase.

Amphiboles of this inner aureole build large prisms (up to 2mm. or more in length) that are not so sieved as before. $Z \wedge c$ somewhat increases and hornblende has Z deep bluish green, Y pistache green, X pale greenish yellow. In varieties at direct contact with the granite or included as xenoliths in it, hornblende is olive green, light pistache and greenish yellow respectively. Biotite is rather rare in the metadolerites of this zone but is more common in the metabasalts except those at direct contact with the granite. It is the nut-brown variety (not deep red brown or wine-red) and is sometimes with feeble pleochroic haloes. Small biotites in the matrix of the metabasalts may crystallise in subparallel flakes probably along pre-existing shear planes.

Apatite is a prominent accessory. Its needles inside the large plagioclase plates sometimes form a peculiar arrangement resembling the spine of a fish with one long and large central needle situated along the cleavage of the felspar and a number of smaller needles arranged at an angle on both side of it. The amount of sphene varies considerably in different varieties while opaques may persist though in a reduced amount up to the direct contact with the granite and may not change to sphene or only partly do so. This is especially noticeable in the metabasalts and may reflect an original smaller content of titanium (particularly in the opaques) as compared with the metadolerites.

Grain size of these rocks, though coarser than before is still too fine for good modal determinations except in certain metadolerites, e.g. modes A and B, Table I. The typical mineral assemblage of this zone is : *hornblende, basic oligoclase* (rarely andesine) and casual accessories of biotite, clinozoisite, quartz, sphene, magnetite and apatite.

It must be noted, however, that post-granitic retrogressive effects had in some cases affected the mineralogy of these rocks whereby amphiboles and biotite were altered to chlorite, plagioclase became clouded and new hydrothermal quartz, calcite, epidote etc. were formed again. These effects are in most cases usually mild and should not be confused with those pertaining and characteristic of the high metamorphic grades, e.g. pennenite

after the hornblende and biotite is different from the chlorite so common outside the aureole as shown earlier in the meta-andesites.

TABLE I.

Some Metadolerites of the Contact Aureole

	A	B	C	
Hornblende	24.53	54.33	45.23	**N.B.** Localities of specimens are indicated in fig. 2.
Plagioclase	58.15	44.93	43.49	
Quartz	4.70	pres.	— —	
Epidote	1.76	0.08	2.18	
Sphene	2.65	0.61	8.97	
Apatite	pres.	0.05	pres.	
Chlorite	8.21	pres.	pres.	
Calcite	— —	— —	0.13	
	100.00	100.00	100.00	

3. *Metadolerites and metabasalts in the sector of the country rock just east and southeast of the southern tip of Gebel Atshan :* Though the country rock in this part of the area should apparently be in a metamorphic grade equivalent to that west of Gebel Atshan, yet as mentioned earlier in the meta-andesites, the metadolerites and metabasalts here also display higher mineral assemblages equivalent to those in the outer zones of the contact aureole (fig. 2). As said earlier, this may be due to a proximity of an underlying part of the granite there, or perhaps to a more preferred transmission of thermal gradients and hot exudations in that direction than to the west. Thus a coarse metadolerite (Mode C, Table I) from this part, consists almost entirely of large (3 - 4 mm. long) prisms of amphiboles with ragged edges and highly clouded and granulated plagioclase which is probably as basic as andesine. Opaques show transitional alteration to sphene at their outer borders while clinozoisite granules, some with yellowish allanite nuclei, are casual in the clouded plagioclase. In a metabasalt nearby, originally porphyritic, the rock consists of hornblende, biotite and granular oligoclase with little clinozoisite and opaques partly changed to leucoxene. Some retrogressive calcite and pennenite are present.

Summary of the metamorphism of the country rock:

The typical mineral assemblages of the metadolerites and metabasalts can be summerised as follows (accessory minerals bracketed) :

1. Chlorite-carbonate-albite-ore (quartz).
2. Actinolite-leucoxene-albitic oligoclase-clinozoisite (quartz, opaques).
3. Hornblende - oligoclase (to andesine) -sphene (biotite, opaques).

The first assemblage represents the regional one outside the contact aureole. It is typical of the greenschist facies. The second assemblage is that of the outer contact aureole and is typical of the epidote-amphibolite facies while the third is of rocks in the inner contact aureole and is equivalent of the amphibolite facies. The third assemblage also covers that of border xenoliths in the granite. Plagioclase becomes more basic from the first to the third assemblages.

The above assemblages are very similar and comparable to those of epidiorites, "greenschists", "greenstones", greywackes, chlorite-schists and metadolerites recorded from many regions, e.g. Wiseman (1934), Harker (1939), Turner (1948, pp. 76, 90 - 91, 94) and references cited in the last work.

The mineral assemblages of the meta-andesites are quite similar to those of the metadolerite suite except that quartz is more frequent in all assemblages, biotite more frequent in the second and third assemblages and the plagioclase there is not as basic as andesine.

It must be mentioned, however, that the high grade mineral assemblages need not to have passed first through the lower grades in the present area. The thermal effects of the granite might have acted on country rock unlike that at present regionally exposed outside the contact aureole. The shears produced originally by the orogenic deformations in that country rock outside the contact aureole must have favoured and hastened the development of the present retrogressive mineral assemblages in them. This notion might also explain the better preservation or "regeneration" of the original textures and structures in the country rocks inside the contact aureale than outside it.

VI. — THE QUARTZ DIORITES

A suite of dark grey granite-looking minor intrusions are encountered casually in the country rock, especially in that part near the main granite. They are particularly more concentrated in the sector just northwest of the southern half of the motor track of fig. 1, where they occur mostly in the form of very irregular sheets no thicker than a few yards across and may enclose small xenoliths of the country rock.

Their grain size is rather medium to coarse and sometimes when much weathered or sheared, their plagioclase felspars look pinkish or purplish owing to fine hematite dust alterations. Inspite of their wide distribution and relatively small size of their intrusions, individual bodies show quite similar features in thin sections and in modal compositions (Table II).

In thin section (fig. 14), the least sheared varieties are made up of fairly robust euhedral to subhedral crystals of plagioclase (up to 7 mm. in length and 4 mm. in width) arranged haphazardly and must have been originally the first to crystallise followed by the ferromagnesian minerals and later by quartz which characteristically moulds, in smaller grains, against the spaces between the plagioclase. The plagioclase plates show traces of well developed lamellar twinning though the interiors are always clouded by alterations and at present indicate a composition of intermediate oligoclase ($Ab_{80}An_{20}$) while the outer zones are of albitic oligoclase. The alteration material consists of amorphous dust, sericite mica, tiny granules of clinozoisite as well as inclusions of small biotite and chlorite flakes probably representing alteration material that had originally migrated from the adjacent altered ferromagnesian minerals. Sometimes the plagioclase plates are sheared and cracked with chloritic material lining the cracks.

The ferromagnesian constituents are usually segregated into large knots that are replaced now by dense aggregates of brown or olivebrown flakes of biotite variably replaced by green pennenite (with ultrablue, violet and brown interference colours) and rare prehnite. So far no trace of amphibole has been found in such aggregates but the original pre-existence of hornblende before its replacement by biotite is not improbable. In some varieties, the small biotite flakes show some sort of crude alignment.

TABLE II.

Some Quartz-Diorites

	A	B	C	D	AVERAGE
Plagioclase	53.90	59.03	57.77	60.21	57.73
Quartz	27.92	22.99	30.85	22.89	26.16
Biotite*	15.13	12.79	4.16	10.37	10.61
Opaques		pres.	1.34	pres.	0.34
Apatite	0.19	0.54	0.27	pres.	0.25
Calcite			5.03	0.11	1.28
Prehnite			0.58		0.15
Sphene	0.14	4.51	pres.	0.97	1.40
Microline	0.18			3.35	0.89
White mica	2.33				0.58
Epidotes	0.21	0.14		2.10	0.61
	100.00	100.00	100.00	100.00	100.00

* Mostly chloritised and part of the resulting pennenite might not be after biotite.

Localities of specimens are indicated in fig. 2.

Though part of the quartz in some varieties is secondary and hydrothermal being introduced later, yet the greater part of it is clearly primary. It may show weak optic strains as well as crude flattening of the grains. Its modal amount never falls below 20% by volume of the rock and quartz thus ranks next to the plagioclase.

Original potash felspar is characteristically absent from this suite of intrusions and in the few cases it was found (e.g. Mode D, Table II), it is clearly late being introduced from the nearby or adjacent granite. The main alkalic ingredients for microcline, perhaps also for the biotite, might have thus largely diffused from the granite and replaced the plagioclase in the form of tiny intergranular films or small grains.

Because of the probable absence of potash felspar and the rather high content of quartz in the original intrusions, this suite is called here "quartz-diorite" in preference to trondhjemite, tonalite or granodiorite though of course the precise terminology cannot be known owing to the altered nature of their constituents, particularly the ferromagnesians.

Accessories include zircon granules producing dark haloes in biotite or its pennenite pseudomorph, apatite needles particularly frequent in the contact zones of the main granite, sphene, leucoxene and opaque granules (at present hematite or limonite) as well as clinozoisite, calcite, sericite and other alteration products.

The quartz-diorites have not, so far, been observed to be cut by any of the metadolerites. On the contrary, as said earlier, they intrude the meta-andesites and metadolerites and enclose small fragments from them. In certain localities in the field, they seem to be cut by fine grained dark dirty oilish green intrusions that probably belong to the late post-granite dyke intrusions. The date of intrusion of the quartz-diorite suite is probably after the main orogeny and diastrophism of the country rocks have taken place (or just before the waning stages of this diastrophism) but before the emplacement of the main granite of the present area. This is probably so because the quartz-diorite suite is not on the whole as much sheared as the meta-andesites and metadolerites and its members are more frequent in the neighbourhood of the granite, particularly to the northwest. Furthermore, members of this suite in the contact aureole of the granite, appear to have been affected by the contact metamorphism. The quartz-diorites may thus represent early heralds of the intruding granite and their composition affords an interesting link between the earlier doleritic igneous activities and the succeeding granite intrusion particularly as some slightly earlier phases of that granite (the grey granite) are actually granodiorites (e.g. Mode A, Table III).

VII. — THE GRANITE

As can be seen from the map, the main granite of the area has generally a more or less rounded outline but in the field, minor irregular protrusions into the country rock are seen. The most prominent of these is that leading to the pegmatite-aplite Red Hill at the northern end of the granite (fig. 1).

The actual borders of the granite with the country rock are sharp, and apart from the hornfelsing and rare doubtful spotting effects of the country rock in its aureole, and the narrow zone of mechanical and angular xenoliths near some outer parts of its border, there is no apparent indication at the present level of

erosion of any significant interaction or assimilation between the granite and the country rock in the present area. Apart from its border zones, the main granite of the area shown in the map has relatively few inclusions.

As can be seen from fig. 1, the strike of bedding, schistosity or foliation of the country rock is roughly concordant with the outline of the granite but, as the continuation of this granite boss and its country rock south and outside the map-area is not known yet, it is rather difficult to decide whether this granite intrusion had gained its place by pushing and shouldering the country rock or whether it climbed up and occupied fractures and widening gaps (such as anticlinal cores) produced during the regional orogeny. Probably its modus operandi included both mechanisms, i.e. ascending into gaps and weak zones produced by the orogeny and then widening the room thus gained by some pushing against the wall rocks.

The colour and grain size of the granite vary widely but the variation is usually gradual and transitional so that the main granite cannot be sharply divided into distinct well defined bodies. In fig. 1 is shown a rough and arbitrary division of the main granite into four types: medium grained *grey granite*, coarse grained *pale pink granite*, medium to coarse grained *red granite* and medium to fine grained *yellow granite*. The modal composition of some of these four types is given in Table III and the positions of the analysed specimens are indicated in fig. 2. This variation in colour entails thus variation in composition, grain size and texture but the colour of the granite observed in the field must be treated with caution for sometimes a pale pink granite for example when traversed by shear belts or is much weathered along joints or cracks, its colour becomes deep pink or red. This is mostly due to the clouding of the plagioclase felspars which "absorb" hematite and limonite dust, perhaps in part resulting from the release and migration of iron through the chloritisation of biotite. In the following are given details about each type of granite.

1. *The grey granite:* (Mode A, Table III)

This is the most basic of all varieties with plagioclase occupying more than 50% of the volume of the rock. It is actually a granodiorite. The average grain size is about 2 mm. Plagio-

clase tends to form euhedral and subhedral unoriented crystals with a crystal outline better developed than in any other mineral present. Its crystals may reach 4 mm. in length or more and are oscillatorily zoned parallel to the crystal outline. The inner cores appear to be of basic to intermediate oligoclase while the outer zones are of intermediate to acid oligoclase. Microcline microperthite forms large crystals that may enclose several of the smaller euhedral crystals of plagioclase. Biotite (pleochroic from light yellow to sepia or burnt sienna) with dark pleochroic haloes is slightly replaced by green pennenite. No definite hornblende is observed. Compared with other varieties of granite, the grey granite is rich in plagioclase, biotite and accessory sphene and clinozoisite. Part of the last mineral apparently result from alteration of the plagioclase.

In the present area, the grey granite appears to resist weathering and erosion better than other varieties. Except Ras Zareib, it forms the higher ground in the field and weathers into large blocks with rounded edges so that the original jointing there can be easily determined. It is usually 15° west of north, with another less prominent set at 75° west of north.

2. *The coarse pale pink granite:* (Modes B, C, D, E and F, Table III)

The grey granite occupies the southwestern corner of the main granite and merges to the north, northeast and east into the coarser pale pink granite which in turn outwardly merges into the yellow or red granites. Mineralogically the pale pink granite reflects this transition. Its plagioclase is still with distinct oscillatory zones; the inner zones have distinct euhedral outlines while the outer ones give the crystals a subhedral outline. The granite still contains sphene and clinozoisite granules and large biotite (same variety as in the grey granite) flakes more interleaved by pennenite than in the grey granite. The biotite may be also replaced by a peculiar deep reddish transitional mica. Microcline is microperthitic and with casual myrmekite buds.

The pale pink granite near the northern tip of the main granite (e.g. Mode D, Table III) ceases to have distinct oscillatorily zoned plagioclase. Clinozoisite and sphene are scarce and the biotite is more altered by pennenite and prehnite but the secondary hydrothermal muscovite flakes replacing the clouded

TABLE III.

Composition of Some Granites

	A	B	C	D	E
Plagioclase	54.04	39.77	48.41	25.43	37.05
Pot.felspar	15.91	26.72	22.02	37.50	35.49
Quartz	18.43	29.67	20.99	31.91	24.17
Biotite	9.15	2.64		4.23	2.45
Pennenite	0.62		8.58		
Muscovite				0.93	0.62
Myrmekite	1.46	0.51			0.22
Sphene		0.55			
Clinozoisite	0.24	0.14			
Opaques					
Apatite	0.12				
	99.97	100.00	100.00	100.00	100.00

	F.	G	H	I	J
Plagioclase	35.43	35.09	43.78	38.03	39.92
Pot.felspar	34.86	23.52	24.21	23.97	38.04
Quartz	24.46	39.35	29.87	29.03	21.48
Biotite	1.96			2.72	0.07
Pennenite					0.04
Muscovite	0.80	2.04	2.14	6.02	0.19
Myrmekite	2.39				0.26
Sphene					
Clinozoisite					
Opaques	0.10			0.23	
Apatite					
	100.00	100.00	100.00	100.00	100.00

A : Grey granite.
B, C, D, E and F : Pale pink granites.
G and H : Red granites.
I : Yellow granite.
J : Small aplite red dyke cutting the pale pink granite.

Localities are indicated in fig. 2.

plagioclase attain larger sizes than before. Still northwards into the narrow intrusion shortly leading to the red granite of the Red Hill, the pale pink granite shows for the first time distinct aplite-pegmatitic features (modes E and F, Table III). It becomes spangled with coarse oval pegmatitic patches containing very coarse potash felspar and quartz with some plagioclase and hardly no mica. Some of these patches are enclosed in ring-shaped biotite schlieren described elsewhere (Gindy, 1956 A). The granite itself there contains large (up to 1 cm.) crystals of quasi-graphic intergrowths between potash felspar and quartz; the latter occurring in rounded bleds, rods and irregular small patches of the same optical continuity inside the potash felspar plate (fig. 15). Like other large potash felspar plates, these intergrowths may enclose the smaller earlier formed plagioclase crystals. Sphene and clinozoisite are absent and plagioclase is lightly or weakly zoned.

In the field, the pale pink granite displays spheroidal weathering as well as low-lying jointing of the typical sheeting type. It occurs in fragmental and highly decayed conditions and because of its rapid weathering it forms the low and wide sandy plain (in the northern half of the main granite) that contrasts with the wild and rugged country rocks opposite to it. In the narrow northern "bottle-neck," this granite sends several small but highly irregular branches into the country rock.

3. *The red granite:* (Modes G and H, Table III)

The red granite is medium grained (average grain diameter about 2 mm.) but in the quartz-felspar mosaic large subhedral, unzoned and unoriented crystals of plagioclase (up to 5 mm.) occur. These are extensively clouded by iron stains and dust which gives the rock its red colour. The altered plagioclase appears to be acid oligoclase, if not albite. Myrmekites and vein-perthites in the microcline plates appear to be rarer than in the pale pink granite. The red granite seems to be either a straightforward muscovite-biotite granite (i.e. with primary muscovite) or a biotite-granite that had part of its biotite replaced by pseudomorphs of white mica at an early date soon after its crystallisation with the consequent release of opaque granules. Some of the large primary-looking white mica flakes are slightly pleochroic with Z distinct cream and X colourless.

Sphene and clinozoisite are totally absent. The granite is virtually an aplite.

The red granite apparently resists weathering much better than the coarser pale pink granite and it forms the conspicuous Red Hill just south of the motor track between Atshan and Hamadat mines and the high rosy peak of Ras Zareib (mode G).

4. *The yellow granite:* (Mode I, Table III)

This granite forms the outer aplitic border zone to the red and pale pink granites at the northeastern corner of the main granite. A typical yellow granite is white or yellowish in colour and is aplite-looking, fine grained (average grain diameter below 0.5 mm.) with glistening spots of white mica and dark dots of biotite. It is characteristically a muscovite-biotite granite, sometimes with the two micas in intergrowths. The fine granular mosaic of the rock contains some felspars, particularly potash felspar in tiny quasi-graphic intergrowths with quartz like those observed earlier in the outer parts of the pale pink granite. Apart from the primary muscovite, some of the large shredded flakes are definitely secondary after the plagioclase. The plagioclase is not zoned and sphene and clinozoisite are absent but tiny opaque granules may occur. Some varieties are spangled with large cubes (sides 5 mm. long) of pyrite or hematite or limonite pseudomorphs after pyrite. Similar cubes etc. are found in other varieties of the main granite but it is probable that they have been hydrothermally introduced later and have not directly crystallised from the granite. Apatite is scarce in all varieties of the main granite while it is so abundant in tiny needles in the country rocks, particularly those of the contact aureole.

Concluding remarks on the main granite:

No flow trends [4] or any other linear features attendant on the intrusion of the main granite were observed in it but from the above description it seems that the grey granite represents a slightly earlier crystallised and more basic fraction of the main granite while the still more fluid and relatively more acid residual fractions and the fugitive constituents concentrated to the outer northern and eastern borders of the intrusion

(4) Except the rare border case mentioned elsewhere (Gindy, 1956 A, p. 147, 148 and figs. 1 & 11).

(perhaps guided by the opening gaps and fissures in the country rock causing partial decrease of pressure there). This residual magma crystallised then as the red and yellow granites with the pale pink granite transitional to the grey granite. The red and yellow granites are actually pegmatite-aplite border varieties of the main granite. Indeed, even the grey granite itself, at some parts just before its immediate sharp contact with the country rock west of it, is observed to pass within a very narrow zone (few inches wide) into aplite and pegmatite varieties too narrow to be shown in the maps. Red aplite dykes and veins (e.g. Mode J, Table III), very similar to the red granite, traverse the grey and pale pink granites.

The grey granite (actually a granodiorite) acts, as mentioned earlier, as a link between the preceding quartz-diorite intrusions on one hand and the rest of varieties of the main granite on the other hand. From evidence observed in adjacent areas which the writer is at present still studying, the grey granite there appears to have evolved through advanced "assimilation" of basic country rock inclusions in a granite magma perhaps of a composition near that of the pale pink granite. This assimilation must have taken place at deeper levels before its present emplacement where assimilating tendencies appear to be largely lost even though relics of the inclusions may still persist [5]. At the present level of erosion, and strictly within the limits of the present area, the grey granite is a fairly homogeneous intrusion (igneous, magmatic) with no good signs of "assimilation" of the country rock or its fragments, granitisation etc.

Granites of all varieties show signs of strains in the quartz and bending and shearing in the plagioclase etc. owing to the effects of later tectonics, e.g. the post-Eocene and Miocene

(5) The early quartz-diorites might have evolved in a parallel fashion at depth but for other theoritical possibilities concerning the origin of granodioritic and quartz-dioritic magmas see, e.g. Turner & Verhoogen (1951). Later work by the writer on the larger area shows that the main granitic intrusive pluton has a roughly oval cross-section and is of complex character in parts granitic, granodioritic tonalitic and quartz-dioritic. Partial or selective melting and fusion at depth of sialic and country rock materials (including those of the andesites and associated dolerites) is thought to be the most adequate explanation of these rocks (See Gindy, Third Arab Science Congress, Beirut, 1957).

upheavals. It should be noted that though the four types of granites in the present area happen to occur more or less integrated within a large granite body, this is not necessarily so everywhere, and we may expect in other parts of the same terrain to find separate intrusions of these types or combinations of two or more types (Gindy, 1956 B).

The contact effects of the main granite on its country rock have already been described and it has been mentioned that such effects extend in a broader zone southeast of the southern tip of Gebel Atshan and may denote an underlying part of the granite boss at no great depth (fig. 2A). The country rock in this wide eastern part of the contact aureole contains plentiful and rather large secondary muscovite flakes unlike the country rock in the narrower western part of the contact aureole opposite the grey granite. This large hydrothermal muscovites as well as dense sericitic shimmer aggregates of the eastern fringe must represent alkalic metasomatic exudations from the adjacent red and yellow granites there. The grey granite to the west is too poor in such fugitive constituents to produce similar results on its adjacent rocks.

VIII. — APLITES AND PEGMATITES OF THE MAIN GRANITE

As mentioned earlier, the red and yellow granites and even some outer parts of the pale pink granite can be considered as pegmatite-aplite border phases of the main intrusion and that these phases remained within the confines of that intrusion and did not extricate themselves into separate intrusions into the country rock. The only available "odd" example is the red granite of the Red Hill which forms for itself a small intrusion at the northern tip of the bottle-neck of the main granite.

Relatively few well defined small aplite dykes, few to several inches thick, traverse the pale pink granite, rarely the grey granite, along the jointing (e.g. Mode J, Table III). They are quite similar to the red granite type but are almost devoid of all mica and contain the quasi-eutectic intergrowths of microcline and quartz. The quartz grains in some of these aplite dykes and veins are of the amethyst variety.

Apart from the separate pegmatite-aplite intrusions in the

country rock of the inner contact aureole, aplite intrusions become very scarce in the country rock outside the aureole. Rare odd aplite sills intruded parallel to the bedding between the meta-andesites halfway west of Wadi Beida el Atshan consist of a felsitic quartzo-felspathic mosaic (average grain size below 0.003 mm.) with tiny white mica flakes and casual much larger porphyritic crystals mostly of quartz and plagioclase. The sills may be called felsite-porphyries. They are much sheared parallel to their extension and weather into thin paper-like sheaves.

It is probable that pyrite casually found in such minor acid intrusions is secondary rather than primary, introduced later along shears.

IX. — POST-GRANITE HYDROTHERMAL ACTIVITIES

These activities are considered below separately but it is quite difficult to work out a clear-cut time relation for them. Some are contemporaneous while others may belong to more than one episode.

1. *Sericitisation:* The development of large secondary muscovite flakes and shimmer aggregates in certain parts of the country rock in the contact aureole has been already mentioned. Plagioclases are most easily affected by sericitisation while the accompanying ferromagesian minerals are chloritised. The alteration is facilitated by the occurrence of weak planes, e.g. s-planes and cleavages of minerals, which provide channels easily accessible by the hydrothermal solutions. Sericite may be produced from the late alkalic granite exudations and perhaps from potash released through the chloritisation of biotite.

2. *Tourmalinisation and quartz-tourmaline veins:* Bluish tourmaline grains are found in the matrix of some meta-andesites and metadacites but similar larger grains are definitely associated with irregular small or microscopic tourmaline-quartz veins that traverse the same rocks. Tourmaline ingredients may have diffused from these veins into the matrix of the rocks. Clinozoisite and apatite granules may have formed as accessories to this tourmalinisation but the rare zircon grains in the matrix most probably belong to the original rock.

Similarly, tourmaline (Z dark dirty greenish blue, X pale greyish or yellowish pink) was found in a sheared and shattered

metadacite at the northmost exposure of the country rock west of Wadi Beida el Atshan (fig. 17). It occurs sparsely in the matrix of the rock but is much more frequent in the fine reticulate and irregular quartz veins filling the fractures where some of the tourmaline crystals are 1 mm. long. Pyrite cubes also occur in these tourmaline-quartz veins. The veins are usually composite [6] in the sense that the tourmaline-quartz areas of the veins are surrounded from either side by a conspicuous sheath of granular quartz devoid of tourmaline (fig. 16). This rock occurs very near to the fault running between Wad Kareim and Wadi Beida el Atshan and bringing the ancient country rock there into contact against the Cretaceous and Eocene rocks. If these tourmaline-quartz veins are post-faulting, they may belong to the post-Eocene, more probably Miocene mineralisation and may be connected with the lead-zinc mineralisation in the Miocene of Um Gheig near the Red Sea, south of Qoseir. However, their date remains uncertain and they may still be Pre-Cambrian in age.

3. *Sulphide activities, pyritisation, hematite and malachite veins and stains:* Along the trace of the fault just mentioned, the shattered country rocks are usually stained red, violet and green owing to hematite and malachite stains. Another locality is in the country rock about 500 yards east of the triangulation pole on Gebel Atshan near its southern end. Here, malachite and azurite stains, veins and permeations are more intense along a narrow zone, probably a shear belt, filling fractures and some joint planes. Cubic pseudomorphs of hematite after altered pyrite are also very common in this country rock and pyrite certainly pre-dates the copper-carbonate veins. No trace of Cu-sulphides exist. The deposit is valueless.

Pyrite or its pseudomorphs were mentioned several times

(6) While most of the calcite (and any other carbonate) veins and some of the quartz veins might have evolved as sweatings from their host rocks by metamorphic-metasomatic differentiation, there is as yet no good evidence to warrant such an origin to the tourmaline-quartz veins which are very few in number and were actually observed in only two small localities within the entire area. The zoning sometimes observed in them (Fig. 16) might otherwise be explained by repeated introduction of fluids of different compositions or of fluids of changing composition etc.

earlier as occurring in the country rock, especially in the sheared zones, and in the granites and aplites, especially the yellow and pink granites. Chalcopyrite or other sulphides may also be present in much smaller amounts than pyrite but no special check for them was made.

Doubt has also been expressed earlier about the origin and date of these sulphides; whether they are primary, secondary or belong to more than one episode of mineralisation. Little is known or published on the Miocene mineralisation of the Qoseir area. As primary pyrite cubes are present in some of the quartz dykes and veins mentioned below, it is reasonable to link the pyritic hydrothermal activities with the period of intrusion of these dykes and veins, i.e. pyritisation is pre-Cambrian. Definite sulphide ores of copper were not observed, nor their pseudomorphs. Only the carbonates (perhaps also cuprite) transported in veins and stains already mentioned. These minerals must have been deposited from late circulating solutions (ascending ?) that had previously leached the copper from its primary sulphide ores (presumably at depth as may be suggested by the deposition of copper carbonates around cubic hematite pseudomorphs after pyrite at the present level of exposure). E.M. El Shazly and A.H. Sabet (Geol. Surv. Egypt., paper No. 2, 1955) have just described a somewhat similar copper deposit at El 'Atawi ancient mines, about 70 km. SSW of Qoseir.

4. *Calcite veins and dykes:* Tiny veins, often microscopic of calcite with variable amounts of quartz and scarce chlorite are frequent in the country rock. They may be irregular or straight along incipient jointing and s-planes. A single odd but conspicuous coarse "calcite-dyke," about 4 inches thick occurs near the foot of the hill-slopes east of the beginning of Wadi Kareim. It is almost made up entirely of coarse pure transparent calcite crystals with excellent cleavage. A very thin intergranular film of hematite gives the dyke a pink colour. Quartz is present in rare intergranular plates. Sometimes the dyke passes into reticulate veins connected together (7).

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(7) Large calcite crystals from the veins fluoresce in beautiful purplish crimson to rosy colours when exposed to ultraviolet light. A.I. Ghozlan, using nuclear photographic emulsions, had determined the alpha-radioactivity of one of these crystals as equivalent to a content of 2.360 parts per million of U_3O_8.

Irregular large and shreded calcite grains scattered in the country rocks, even those of the contact aureole, indicate definite hydrothermal post-granite retrogressive effects. The ingredients of this calcite and other carbonate veins were probably derived from the alteration of the country rocks themselves by intergranular fluids followed by leaching and concentration in fractures etc. (metamorphic-metasomatic differentiation).

5. *Quartz dykes and veins:* Quartz-dykes of bright white or milky colour form a very distinctive feature of the area (fig. 1). They run in almost swarm-like subparallel fashion and cut both the country rock and the granite and in the field, their colour conspicuously contrasts against the dark metamorphics. They have not been observed to traverse the young sediments overlying the igneous and metamorphic rocks. Their trend is distinctly NE to SW striking between 15° to 50° east of north. Usually they are either almost vertical or steeply inclined to the northwest. Their trend is identical with that of the jointing, especially that of the country rock, and is at a large angle to the general bedding, schistosity and foliation.

The width of these quartz-dykes ranges from a foot or more down to straight veins, along joint planes, no thicker than a fraction of a millimetre. Sometimes the dyke is of a reticulate type or encloses angular fragments of the host rock especially when the latter had been previously sheared (fig. 18).

The larger dykes are often somewhat "cavernous" especially near their centre where fine euhedral and concentrically zoned quartz crystals line the cavities in parallel growths. The cavities may also be filled by a younger generation of fibrous or fine granular pink or red quartz (enclosing microscopic dust of hematite) moulding against and contrasting with the earlier milky quartz. In the larger quartz-dykes also, there is often peculiar infillings of dark greenish films and strings, sometimes in larger crystal-like outline. Three polished specimens of this material were kindly examined by Dr. F.M. Nakhla and did not reveal the presence of any ore while other thin sections showed the greenish dark material to be green chlorite, less often epidote introduced into the quartz dykes and veins by still later hydrothermal infiltrations. Calcite may be present in few broad polygonal plates.

Pyrite cubes have been observed sparsely in only few of these large quartz-veins but they might have been more frequent previously but were then altered and washed away by circulating solutions.

The intrusion of the quartz-veins and dykes into the country rock, very often produces mild retrogressive effects on the contact zones of the latter such as increase in sericitisation and clouding of plagioclase, chloritisation and epidotisation (see No. 6 below). In the field, some wallrock alteration to sericite and/or clay minerals is made vividly clear by the bleaching-like whitening of the host rock adjacent to the quartz or quartz-pyrite veins.

The characteristic trend of the large quartz-dykes, their casual cavernous or composite nature would indicate earth forces (tensions ?) favouring the opening of joint-planes in a NE - SW trend about the time of formation of these dykes.

6. *Epidotisation and epidote veins:* Hydrothermal deep pistache green to pale yellow epidote granules contrast with the pale clinozoisitic epidotes of the contact aureole, and are casual in the country rocks occurring chiefly as alteration products after plagioclase. They may be segregated into well defined quartz-epidote veins and thin dykes of strikingly peculiar yellow or pistache green massive appearance. These traverse both the country rock and the granite and sometimes form linings between the quartz-dykes and veins mentioned above (No. 5) and the adjacent country rock. Such discrete quartz-epidote veins and thin dykes are conspicuously better developed in the south-western quarter of the map-area than elsewhere. Strings of epidote granules may also form at the outer border of country rock inclusions inside the quartz-veins (fig. 19) as well as between the constituent minerals of the inclusion, particularly replacing the plagioclase. In such cases, the production of epidote must have been prompted by these hot siliceous introductions though its main ingredients are derived from the country rock itself. Epidote may thus either form in situ or become seggregated with quartz into the discrete veins. A very thin greenish or yellowish crust or veneer is sometimes observed on the face of jointing of the granite and country rock and probably contains epidote with some chlorite and clay minerals.

The hydrothermal epidote has a variable composition. It may be even colourless and clinoziositic but mostly it is strongly pleochroic from deep yellow or pistache green to paler colours.

X. — LATEST MINOR IGNEOUS INTRUSIONS

A suite of igneous intrusions mostly in parallel swarms cut all preceding rocks including the quartz-dyke swarms. Unlike the latter, which had a preferred NE-SW trend, these dykes have a preferred N-S trend swerving few degrees to the east in the eastern half of the map-area and to the west in the western half, perhaps indicating earth tensions of a trend different from those of the quartz-dykes' episode at the time of their intrusion. The NNE-SSW trend is also that of the more prominent jointing in the granite. Beside the well defined dykes 3 or 4 metres across, the same igneous material may occur as irregular and disconnected taperings occupying any available fractures and weak planes in the granite.

Thin sections reveal a fine grained panidiomorphic and unoriented trachytic or bostonitic plexus of acid felspar laths with albite lamellar twinning. Average length of laths varies; in the relatively coarser varieties it is up to 1.3 mm. The ferromagnesian plates are in a subophitic relation to the felspar laths while primary intergranular or interstitial quartz moulds against both minerals. In the present area, this suite of dykes are generally hydrothermally altered (perhaps automatically) so that all the ferromagnesian minerals are replaced by olive green chlorite-like pseudomorphs, the felspars are highly clouded and the whole rock is dusted with hematite particles, sometimes so thickly that they give the originally dark greyish dyke a characteristic bright brick-red colour as in the long dykes in the eastern half of the map-area. Dessiminated grains of calcite are also present.

Because of their altered nature, particularly of their mafic constituents, these rocks cannot be classified properly. The sliced specimens are definitely too basic for a bostonite and approach perhaps to a camptonitic lamprophyre or, more probably, belong to the grorudite-solvsbergite series.

In the present map-area, none of these late igneous intrusions has been found to cut the Nubian Sandstone or younger

rocks though such intrusions are known to occur in neighbouring areas (e.g. Beadnell, 1924, Plate I), and may belong to suites of different ages and compositions. No direct relation between these intrusions in the map-area and the probable faulting there was encountered in the field.

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EXPLANATION OF FIGURES IN PLATES

Fig. 3. — A sheared and altered meta-andesite outside the contact aureole of granite, with relict large porphyritic plagioclase crystals (p). The matrix consists of very fine quartzo-felspathic mosaic with tiny granules of sericite, chlorite, limonite and clay. These minerals occur also inside the altered large plagioclase plates. Ordinary light. × 11.

Fig. 4. — Photograph of a meta-andesite The original pale coloured porphyritic plagioclase crystals are set in a darker matrix. Scale in centimetres.

Figs. 5 and 6. — A porphyritic meta-andesite in the contact aureole of the granite. Fig. 5 is in ordinary light, Fig. 6 is the same under crossed nicols. The fine grained quartzo-felspathic matrix contains biotite, sphene, clinozoisite and apatite. Coarse biotite flakes are concentrated in elongated subparallel knots (bt) occupying the position of formerly sheared mafic porphyritic crystals. Smaller biotite flakes of the matrix are crudely aligned. Minerals of the matrix also occur inside the ancient plagioclase phenocrystys (p) and almost swamp them in fig. 5. × 11.

Fig. 7. — A metamorphosed dacite outside the contact aureole. It consists of relict euhedral quartz (q) and albite (p) phenocrystys in a matrix of a very fine quartz-albite-sericite mixture. Dark grains are late hydrothermal pyrites and epidotes. Ordinary light. × 14.5.

Fig. 8. — A peculiar spotted specimen of the country rock in the contact aureole of the granite. The dark green spots consist at present of fine hydrothermal mixture of chlorite and sericite Scale in centimetres.

Fig. 9. — A metadolerite far outside the contact aureole, consisting of a very clouded and fine matrix of tiny aggregates of albite, chlorite, larger plates of calcite and needles or large grains of ilmenite (black). Compare with fig. 13. This thin section when viewed by a moderate power by reflected light shows faint relics of the dolerite texture. Ordinary light. × 70.

Figs. 10 and 11 . — A metadolerite (perhaps metagabbro) in the outer contact aureole of the granite, in ordinary light and under crossed nicols respectively. The opaques have almost completely changed into broad plates of sphene (s). Clinozoisite granules (c) are numerous in the matrix while actinolitic amphiboles (amp) form poikiloblastically and are seen better under crossed nicols (fig. 11). × 68.

Figs. 12 and 13. — A metadolorite border xenolith in the granite, showing well preserved typical doleritic texture. The plagioclase laths have slightly clouded cores and more acid outer rims. Other chief constituents are hornblende (h), broad sphene (s) moulded against the felspar laths, clinozoisite and late hydrothermal pennenite attacking the hornblende. The rock is rather clear when compared with the metadolerite of fig. 9. Mode of this rock is No. A, Table I. Fig. 13 is part of fig. 12 under crossed nicols. × 70.

Fig. 14. — A typical quartz-diorite consisting of large euhedral psagioclase crystals (variably altered and clouded), biotite and chlorite intergrowths (grey) between the matrix quartz. Mode of this rock is No. A, Tabde II. Ordinary light. × 12.

Fig. 15. — A large grain of quasi-graphic (granophyric) intergrowth between microline (dark) and quartz (light) in a pale pink granite near its transition to the red granite of the Red Hill. Smaller grains are of clouded plagioclase and quartz. The total mode of the rock is No. E, Table III. Crossed nicols. × 12.

Fig. 16. — Two late tourmaline-quartz veins in a metadacite. The veins consist of an inner part (a) containing tourmaline and quartz and an outer part (b) of quartz only. Crossed nicols. × 14.

Fig. 17. — Handspecimen of a shattered metadacite with dark branching tourmaline-quartz veins. Fig. 16 is from a thin section from this specimen. Scale in millimetres.

Fig. 18. — Quartz veins enclosing angular fragments of a meta-andesite (dark), near the Red Hill. Scale in centimetres.

Fig. 19. — Thin section from the specimen of fig. 18. The vein quartz (qz) is highly clouded by dust inclusions and dark epidote granules (e) are formed at some borders of the fragment (f). Ordinary light. × 12.

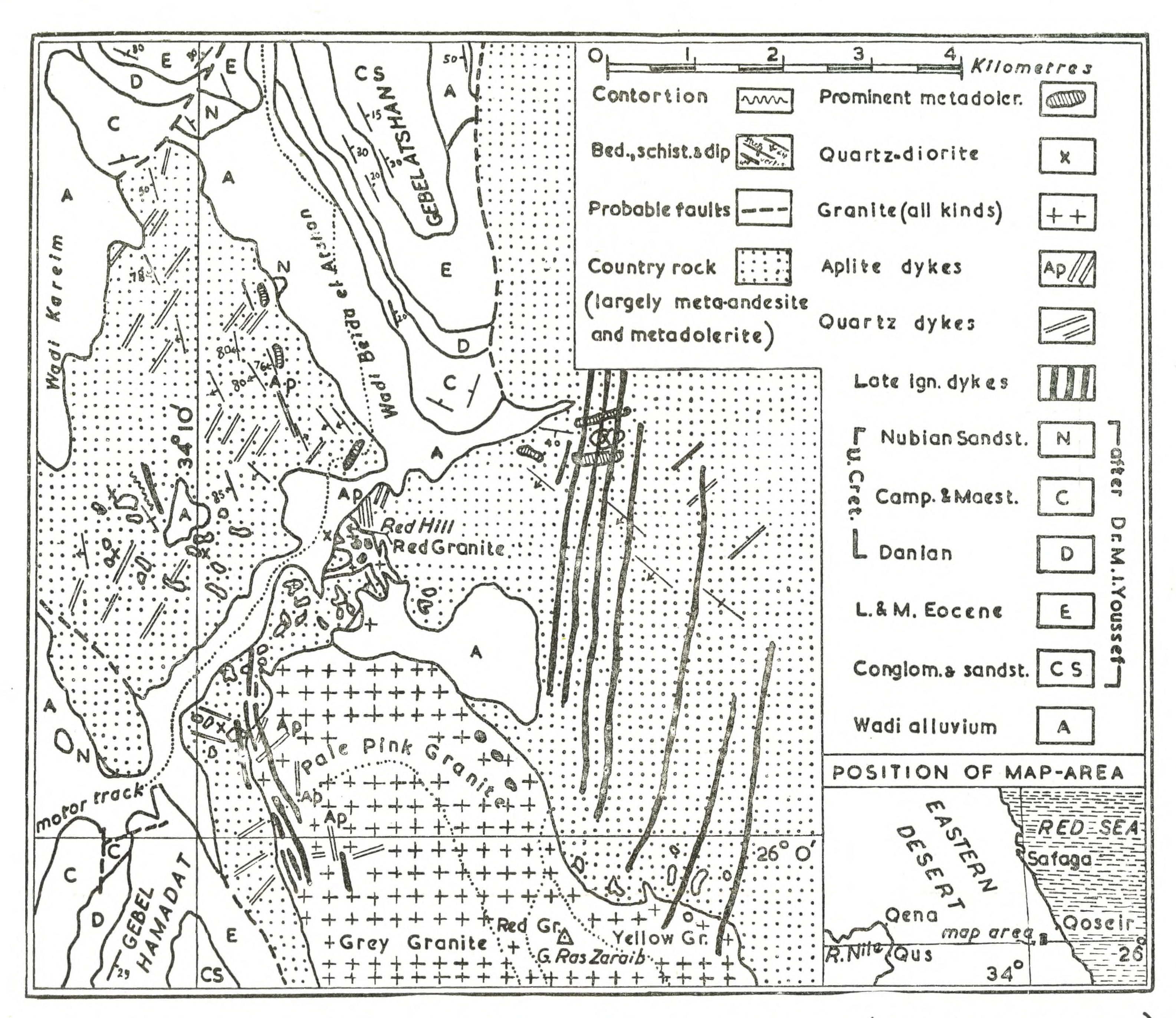


Fig. 1. Geological sketch-map of the Atshan-Hamadat area, near Qoseir. (Original scale 1:50000)

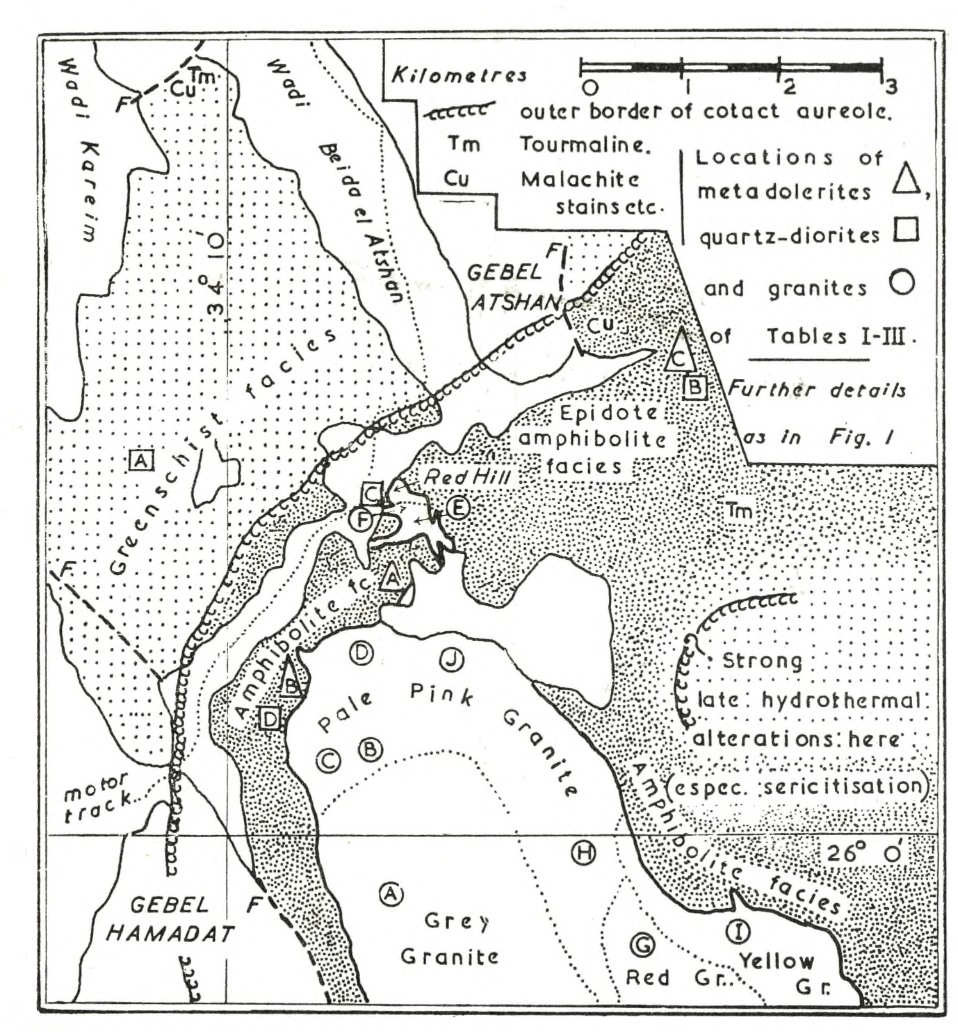


Fig. 2. Distribution of facies, extent of contact aureole and locations of specimens analysed in Tables I-III.

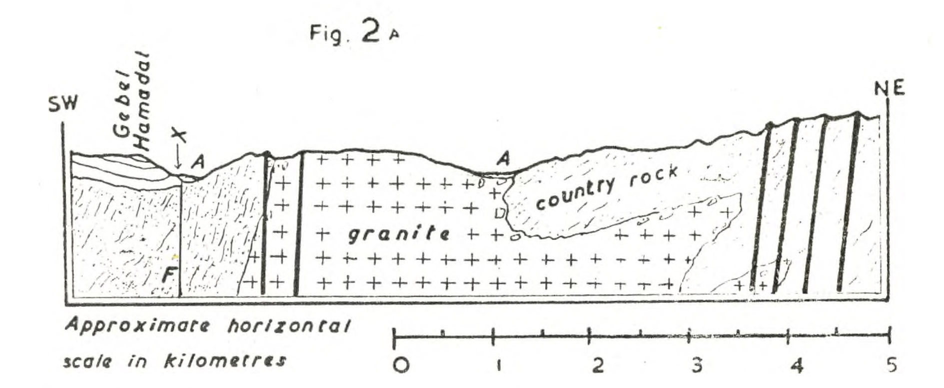


Fig. 2 A — Vertical cross-section through the map-area from SW to NE passing along the intersection of longitude 34° 10' with latitude 26° in figs. 1 and 2. To show the intrusive character of the granite and its disposition along the shear and bedding planes of the volcanic (meta-andesitic) country rock and to explain the broad contact aureole exposed to the NE when compared with the narrow aureole to the SW. Vertical scale fictitious.

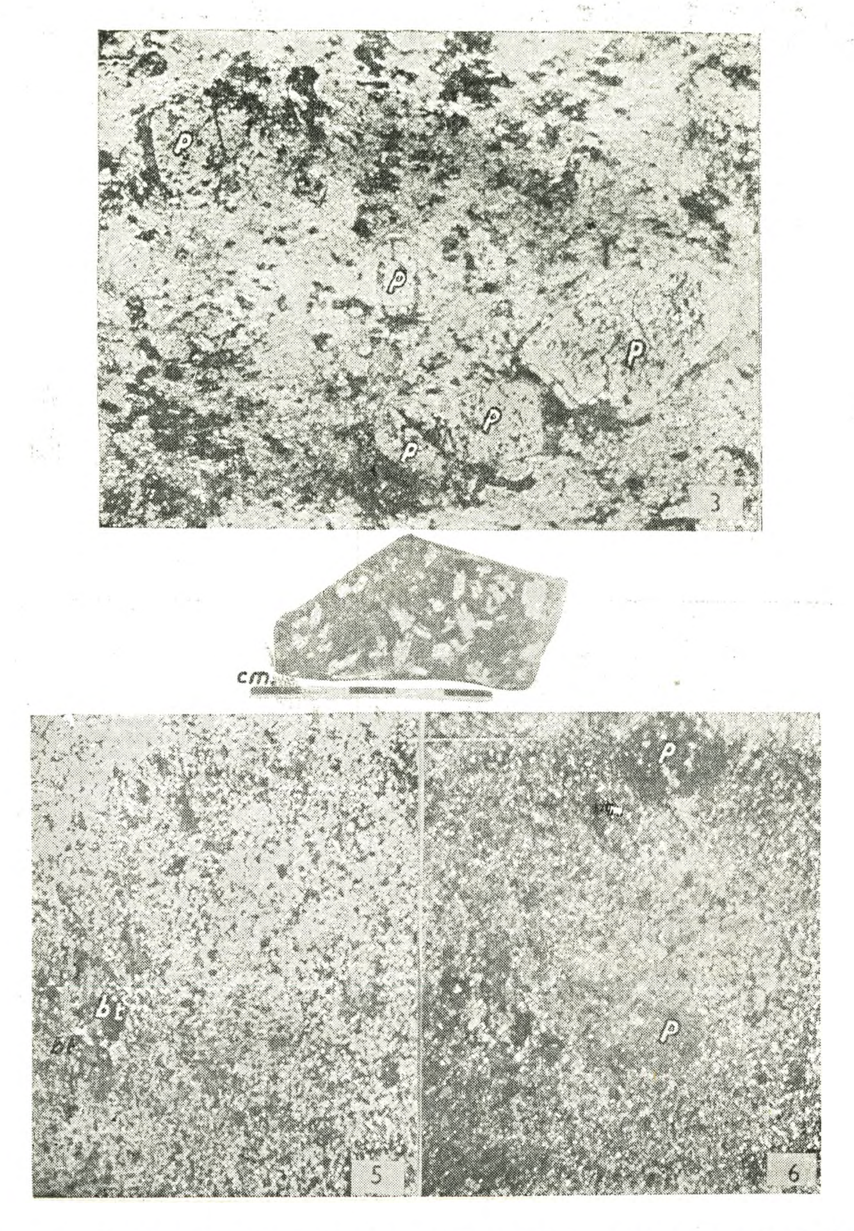


Fig. 3 — Photomicrograph of a meta-andesite outside the contact aureole of the granite with relict large porphyritic plagioclase (p). Ordinary light, × 11.

Fig. 4 — A polished chip of a porphyritic andesite in the greenschist facies.

Fig. 5 — Photomicrograph of a meta-andesite in the contact aureole of the granite: (bt) biotite, (p) plagioclase. Ordinary light, × 11.

Fig. 6 — The same as fig. 5 but under crossed nicols.

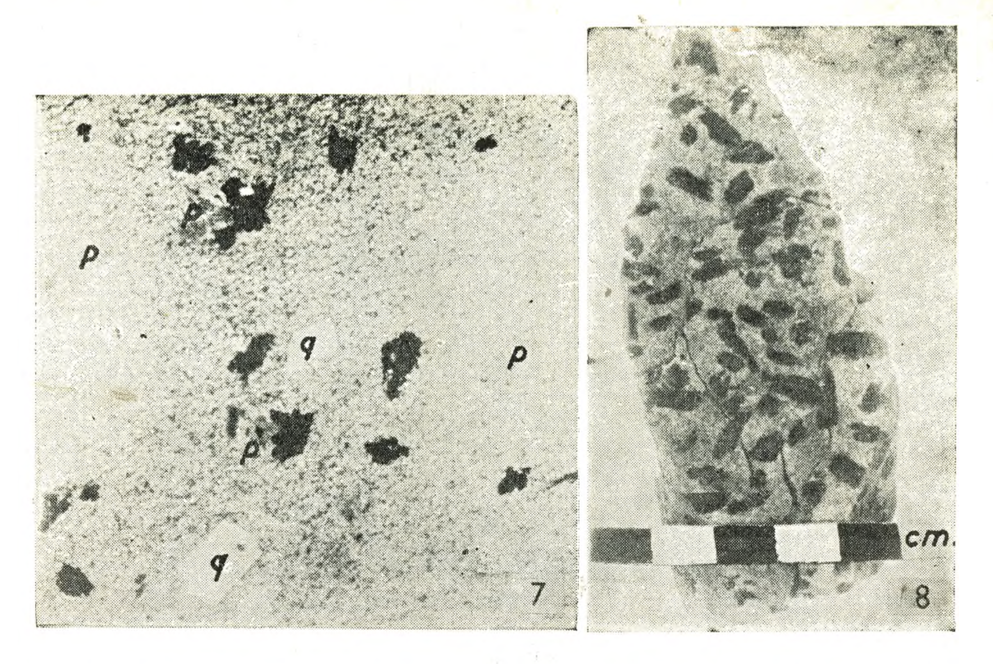




Fig. 7 — Photomicrograph of a metadacite with relics of original porthyritic crystals of idiomorphic quartz (q) and plagioclase (p). Ordinary light, × 14.5.

Fig. 8 — Polished slab of a « spotted » contact rock with the dark « spots » simulating the outine of a pre-exsting ferromagnesian mineral but at present are made of pseudomorphs of retrogressive chlorite and sericite.

Fig. 9 — Photomicrograph of a metadolerite outside the contact aureole. Ordinary light, × 70.

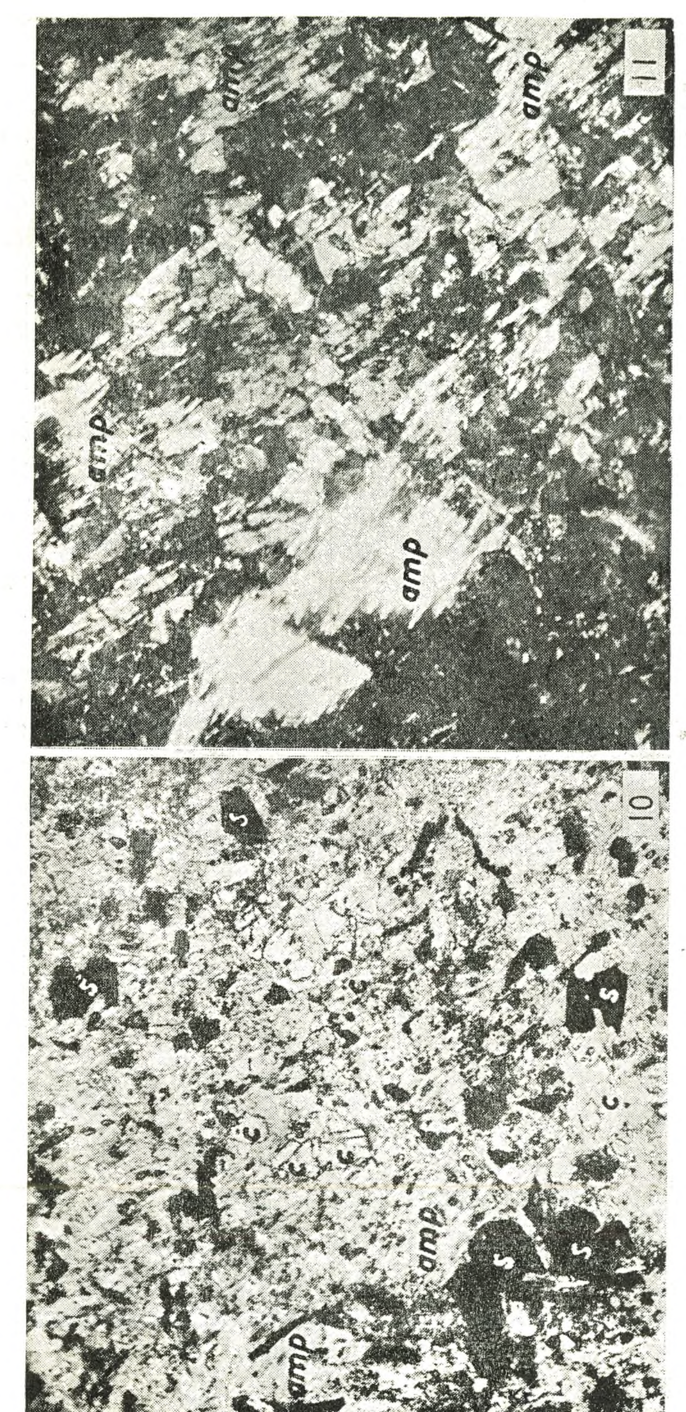


Fig. 10 — Photomicrograph of a metadolerite in the outer contact aureole: actinolite (amp), sphene (s) and clinozoisite (c). Ordinary light, × 68.

Fig. 11 — Same as fig. 9 but under crossed nicols.



Fig. 12 — Photomicrograph of a metadolerite border xenolith in the granite showing typical doleritic texture: hornblende (h), sphene (s), plagioclase: white laths. Ordinary light, × 70.

Fig. 13 — Right half of the photomicrograph of fig. 12 under crossed nicols.

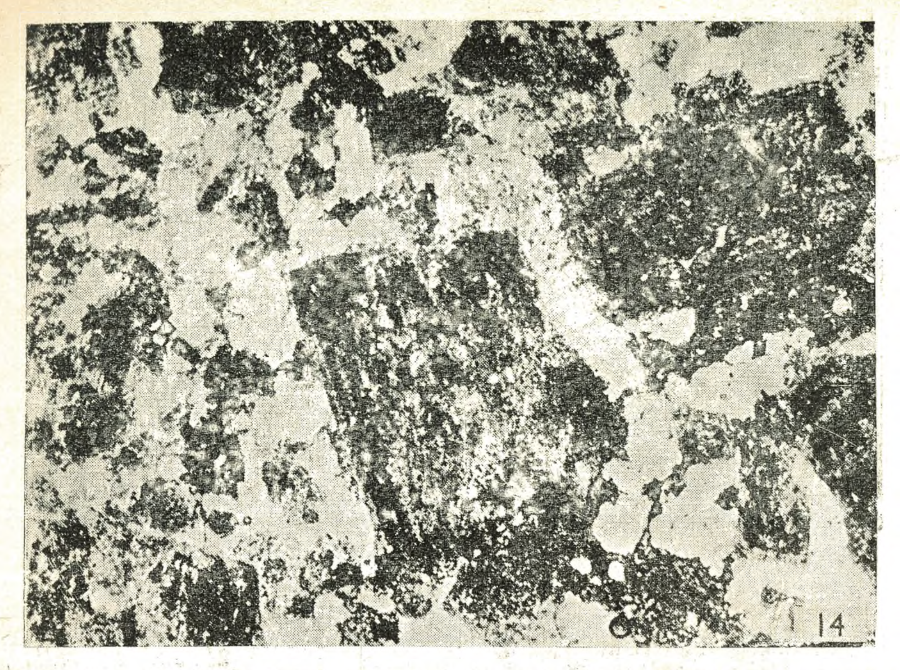


Fig. 14 — Photomicrograph of a typical quartz-diorite intrusion with large euhedral plagioclase plates (clouded). Ordinary light, × 12.

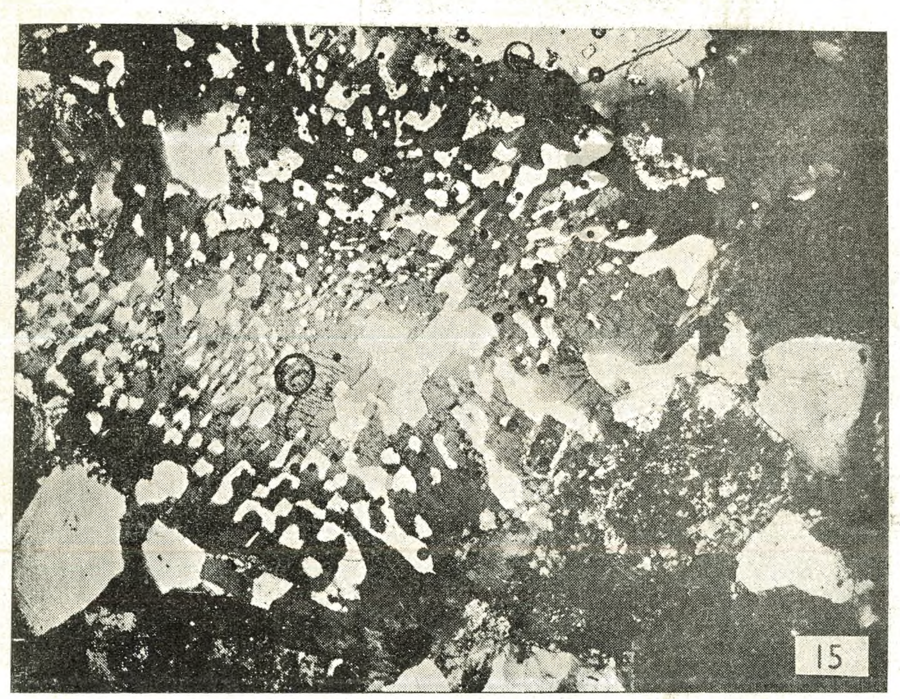


Fig. 15 — Photomicrograph showing a typical grain of quasi-eutectic intergrowth between microcline and quartz in the outer parts of the pale pink granite. Crossed nicols, × 12.

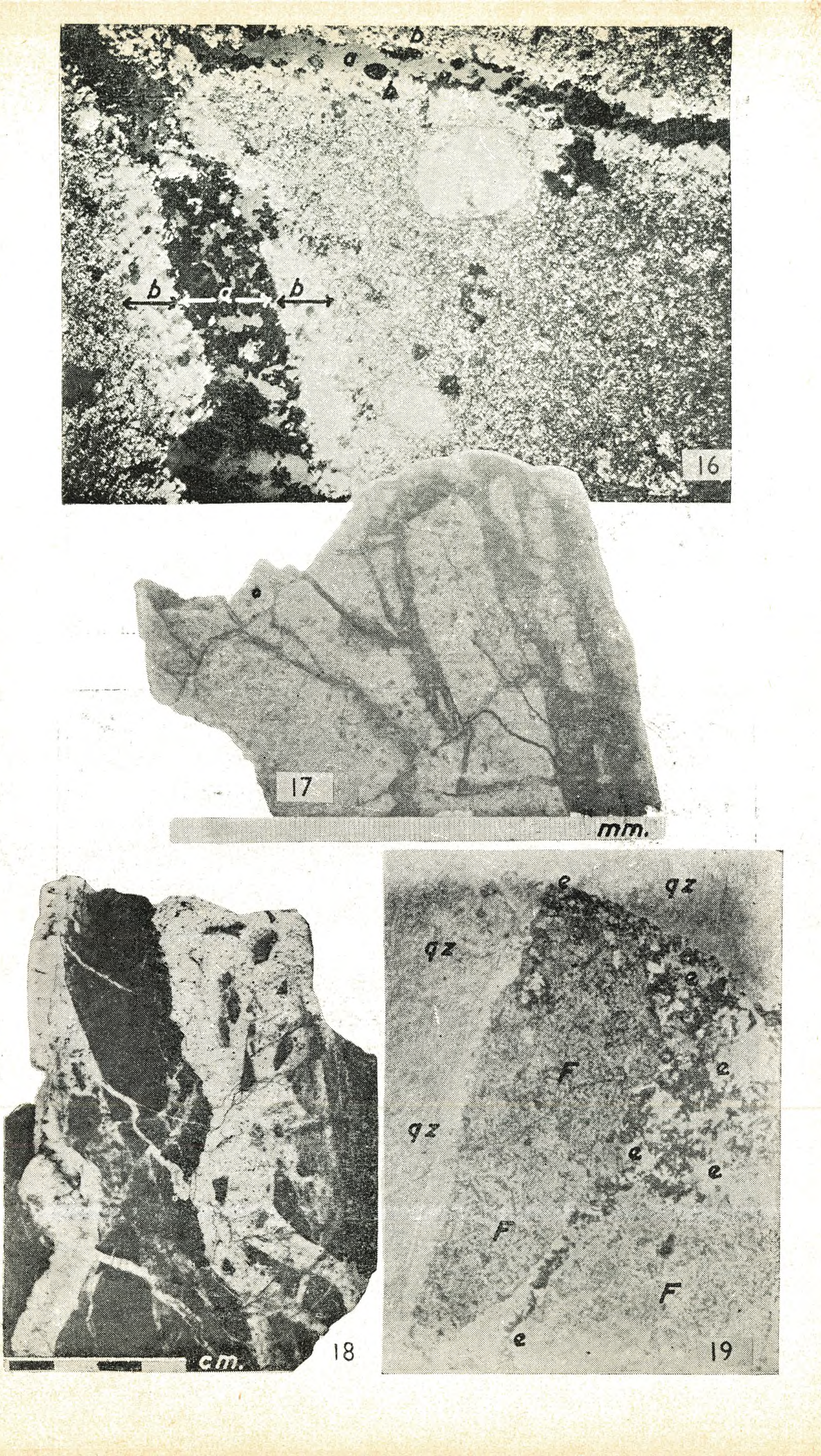


Fig. 16 — Photomicrograph of zoned quartz-tourmaline-pyrite veinlets in the sheared metadacite of fig. 17. The outer zone (b) of the veinlets is almost entirely made up of quartz grains in optical orientations different from those of quartz in the inner zone (a) with tourmaline and pyrite. Crossed nicols, × 14.

Fig. 17 — Polished slab of the veined metadacite handspecimen whose photomicrograph is given in fig. 16.

Fig. 18 — Polished slab of a late quartz-vein material enclosing fragment of the meta-andesitic country rock.

Fig. 19 — Photomicrograph of part of the specimen of fig. 18: (F) fragments of meta-andesite, (qz) vein-quartz, and (e) epidote grains. Ordinary light, × 12.

الآثار المنقوله والمنتحلة
فى العمارة الاسلامية (*)

بقلم

حسن عبد الوهاب

كبير مفتشى الآثار الإسلامية

منيت الآثار على اختلاف عصورها وفى كل زمان ومكان ، بالنقل والهدم ، والمحو والإثبات ، والتزوير والانتحال .

وقد تناول هذا بالنقد ، الإمام الجاحظ منذ القرن التاسع الميلادى فقال « من شأن الملوك أن يطمسوا آثار من قبلهم والعمل على إماتة ذكر أعدائهم فقد هدموا لهذا السبب المدن والحصون . وهكذا كان الحال أيام العجم وأيام الجاهلية ثم فى الإسلام ، فقد هدم عثمان بن عفان صومعة غمدان ، كما هدم الأطام التى كانت بالمدينة . وكما هدم زياد كل قصر ومصنع كان لابن عامر . وكذلك هدم بنو العباس ، ما بناه بنو أمية وبنو مروان من المدائن والمصانع بالشام »[1] .

ويحدثنا التاريخ عن كثير من تلك الاعتداءات التى قضت على طرائف العمارة لغير ما سبب ، إلا ما كان لمحو آثار الظلم والجبروت . ومن ذلك ما فعله أبو جعفر المنصور ، من محاولته هدم أيوان كسرى ثم رجوعه عن ذلك بالخيبة والفشل لمتانته وقوة بنائه .

وحينما روى إلى المأمون هذا النبأ ، قال لمهندسه موسى بن داود « إذا بنيت لى بناء فاجعله ما يعجز عن هدمه ، ليبقى طلله ورسمه[2] » . وهذا الرأى السديد مصداق لما حدث بين الرشيد ويحيى بن خالد حينما طلب منه

(*) محاضرة ألقيت بالمجمع فى جلسة ٢٨ شعبان سنة ١٣٧٥ — ٩ أبريل سنة ١٩٥٦

(١) الحيوان للجاحظ جزء ١ ص ٣٦ — ٣٧

(٢) الطبرى جزء ٩ ص ٢٦١

هدم أيوان كسرى . فقال له : لا تهدم بناء دل على فخامة شأن بانيه الذى غلبته وأخذت ملكه[١] .

وحينما دخل المهدى العباسى الروضة النبوية المطهرة بالمدينة المنورة عام ١٦٩ هـ ٧٨٥ م ، ورأى اسم الوليد بن عبد الملك منقوشاً على طراز الحرم غضب وأصر على عدم مبارحته مكانه ، حتى يمحى اسم الوليد ويكتب إسمه مكانه[٢] .

ونظير ذلك ما فعله أنصار الخليفة المأمون فى قبة الصخرة المشرفة بالقدس ، فانه عقب عمارة أجراها بها سنة ٢١٦ هـ ٨٣١ م محوا اسم منشئها عبد الملك ابن مروان ، ووضعوا اسم المأمون مكانه ، وفاتهم تغيير التاريخ سنة ٧٢ هـ ٦٩١ م فنم عن هذا الانتحال . وما فعله أحمد بن طولون من محو اسم الخليفة المتوكل على الله من مقياس النيل بالروضة .

ويستعرض المقريزى بعض تلك الحوادث معلقاً عليها بقوله :

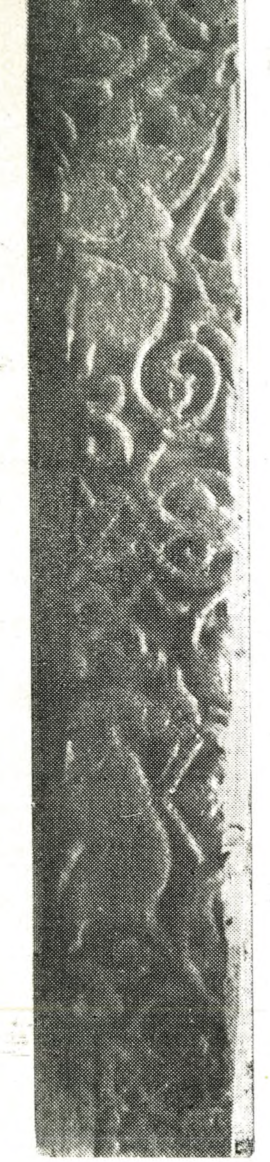
« إذا تأملت البقاع وجدتها ، تشقى كما تشقى الرجال وتسعد »[٣]

هذا قليل من كثير مما حدثنا عنه التاريخ ، وطبعاً هذا ما وقع على آثار مصر على اختلاف عصورها . فى المصرى القديم ، وفى الإسلامى . فها هو مهندس الخليفة العباسى المتوكل على الله يأخذ أنقاض معابد مصرية من هليوبوليس ، وأنقاض كنيسة قبطية ، ويتخذ من أحجارها لبشة حول مقياس النيل بالروضة فى سنة ٢٤٥ هـ ٨٥٩ م لتقيه دفع مياه النيل . وقد استخرج من تلك اللبشة عند القيام بعملية ترميم المقياس ٢٥٠ حجراً مكتوباً[٤] ما بين مصرية وقبطية . ومثله مهندس بدر الجمالى وزير الخليفة المستنصر بالله فانه

(١) الوزراء والكتاب ص ٢٢٩ (٢) الذهب المسبوك فى ذكر الخلفاء والملوك ص ٤٧

(٣) المواعظ والاعتبار للمقريزى جزء ١ ص ٣٤٨

(٤) يرجع الفضل فى القيام بعملية الترميم بالمقياس واستخراج تلك الأحجار إلى المهندس السيد كامل عثمان غالب الوكيل السابق لوزارة الأشغال . قد وضع مؤلفا قيما عنه قام بدراسة قطع من الأحجار مسيو دريتون . كما وضع مؤلفاً عن الأحجار القبطية نشرته جمعية الآثار القبطية سنة ١٩٤٢ .





تفاصيل من الأخشاب الفاطمية المنقولة إلى البيمارستان المنصورى بالنحاسين

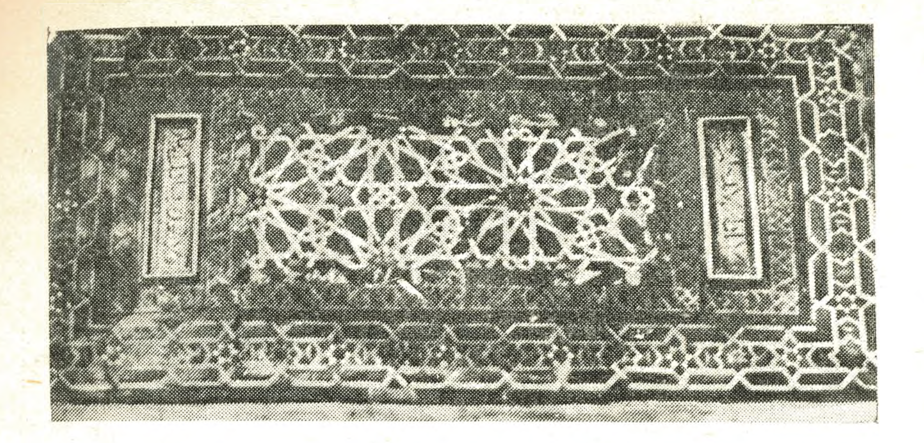
أدخل فى بناء بابى النصر والفتوح والسور بينهما أحجاراً مصرية ما بين جيريه وجرانيتية استعملت فى البنيان بنصوصها الهيروغليفية المرأية والكثير منها استعمل على الوجه الآخر فاختفت نقوشه ، وما زالت بعض القطع محتفظة بكتاباتها وخاصة فى جـرانيت الأعتاب والعتبات فى باب الفتوح وباب التوفيق . وها هو صلاح الدين يوسف بن أيوب فانه مع ما امتاز به من جلائل الأعمال هدم سور مدينة انصنا بالصعيـد[1] وشحن أحجاره ليبنى بها مع أحجار الأهرام التى هدمها وزيره بهاء الدين قراقوش سوراً يحيط بالقاهرة والفسطاط . كما أنه خرب القصور الفاطمية وكانت من عجائب الدنيا ، فبعثرت أنقاضها الهامة ، وأدمجت فى منشئات المنصور قلاوون وغيره ، ما بين رخام وأحجار وأخشاب . فقد عثرت فى قصر الأمير بشتاك الذى حل فى بقعة من أرض القصر الشرقى الكبير ، على قطعة حجر منقوش بها صورة امرأة وغزال . وعلى قطع خشبية فاطمية منقوشة مصورة أودعت متحف الفن الإسلامى . وأدخل فى عمارة المنصور قلاوون التى أنشئت على رقعة من أرض القصر الصغير الغربى، تفاصيل فاطمية هامة لاشك أنها مخلفة من القصور الفاطمية ، ما بين مصاريع أبواب اشتملت حشواتها على كتابات كوفية ، وعلى نقوش دقيقة وصور طيور وآدميين وحيوانات .

وكذلك دخلت فيها أفاريز خشبية نقشت عليها صور الصيد والعزف على الآلات الموسيقية والرقص ، أودعت جميعها متحف الفن الإسلامى .

وما زال فى سقفين بالجزء البحرى من البيمارستان المنصورى ، مجموعة من الأخشاب الفاطمية مستعملة فى غير موضعها ، اشتملت على صور ونقوش وكتابات كوفية فاطمية . وقد سبق لمصلحة الآثار أن نقضت سقفاً آخر كان هناك وفرزت أخشابه المماثلة للباقية وأودعتها متحف الفن الإسـلامى بعد أن درسها مسيو ادمون بوتى وحاضر عنها بالمجمع العلمى الموقر . وكذلك أدخلت فى وزرة القبة المنصورية أجزاء دقيقة من الرخام من أحد الدور مكتوب برأسها « ألا يا دار لا يدخلك حزن ولا يغدر بساكنك الزمان » .

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(١) المواعظ والاعتبار للمقريزى جزء ١ ص ٢٠٤



تفاصيل من وزرة قبة المنصور قلاوون منقولة من أحد القصور ومكتوب عليها
ألا يا دار لا يدخلك حـزن ولا يغدر بساكنك الـزمان



تفاصيل من ألواح رخامية عليها نقوش فاطمية
كانت منقولة إلى أرضية قبة خانقاه فرج بن برقوق

هذا عدا ما عثر عليه من قطع الرخام الحافل بالنقوش الفاطمية وغيرها ومنها قطعة وجدت فى خانقاه بيبرس الجاشنكير عليها صور طيور متقابلة وأسماك ، وما عثرت عليه منها فى أرضية القبة القبلية بخانقاه فرج بن برقوق ، المرجح أنها منقولة من القصور الفاطمية ، فقد اشتملت على صور أسود وطاووس ، ونقوش فاطمية أودعت متحف الفن الإسلامى .

وأن جمال العمد الموجودة فى محاريب مدرسة الناصر محمد بن قلاوون بالنحاسين ، ومحراب قبة الصالح نجم الدين وروعتها فهى من السماق الأحمر والأخضر المرقط تجعلنى أرجح أنها من مخلفات القصور الفاطمية حيث لا نظير لها . ومما لا شك فيه ، أن الكثير من الرخام والأحجار والأخشاب المندمجة فى الآثار الأيوبية ، وغيرها ممن أدركوا أنقاض القصور الفاطمية بعد تخربها ، منقولة منها ومن غيرها ، واستعملت على الوجه الآخر ، بل ومنها ما استعمل مرتين لغرض واحد فقد استعمل شاهد قبر الإمام[1] الشافعى مرتين ولغرض واحد وفقط ليتلافى عدم ذكر الإمامة فى النص الأول ومثله اللوحة المشتملة على كتابة فاطمية واستعملت لوحة تذكارية لإنشاء المدرسة الصلاحية على الوجه الآخر. وهى مودعة متحف الفن الإسلامى .

ومن الاعتداءات التى وقعت على الآثار للحصول على أنقاضها ، ما فعله الملك الصالح نجم الدين عند بناء قلعة الروضة ، فانه هدم كثيراً من المساجد والقصور وأخذ أحجارها واستحضر عمد الجرانيت الضخمة وعمد الرخام من البرابى[2] .

وكما يدين الفتى يدان ، فقد سلط الله مماليكه على القلعة وعلى رأسهم مملوكه المنصور قلاوون ، فهدموا القلعة الصالحية بالروضة وهى فى روعتها وأخذوا أنقاضها إلى منشئاتهم ، ويحدثنا المقريزى عن اعتداءاتهم عليها فيقول :

« ... ولم تزل هذه القلعة عامرة حتى زالت دولة بنى أيوب . فلما ملك السلطان

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(١) تاريخ المساجد الأثرية جزء ١ ص ١٠٩ (٢) المواعظ والاعتبار للمقريزى جزء ١ ص ١٣٨

المعز عز الدين أيبك التركمانى أمر بهدمها وعمر من أنقاضها المدرسة المعروفة بالمعزية بمدينة مصر .

وطمع فى القلعة كل من له جاه ، فأخذ جماعة منهم عدة سقوف وشبابيك كثيرة وغير ذلك من أخشاب ورخام . وبعد أن أصلحها الظاهر بيبرس البندقدارى اعتدى عليها المنصور قلاوون عند بنائه المدرسة والقبة والبيمارستان ، فنقل من القلعة ما احتاج إليه من عمد الصوان وعمد الرخام ، والتى كانت قبل عمارة القلعة فى البرابى ، وأخذ منها رخاماً كثيراً وأعتاباً وغير ذلك . ثم أخذ منها الناصر محمد بن قلاوون ما احتاج إليه من عمد الصوان ، فى بناء الأيوان المعروف بدار العدل بقلعة الجبل ، وفى بناء الجامع الجديد الناصرى على شاطىء النيل بمصر القديمة ، وأخذ غير ذلك حتى ذهبت كأن لم تكن »[1] .

ولما استولى الظاهر بيبرس البندقدارى على قلعة يافا هدمها ونقل أخشابها ورخامها إلى القاهرة وأدمجها فى عمارة مسجده بالحسينية[2] .

ومن عجب أن نرى كذلك الأخشاب تستعمل فى العصر الواحد لغرضين ولعل هذا راجع إلى قلتها . فنرى المحراب الخشبى لمشهد السيدة رقية استعملت فيه عوارض الظهر والأجناب ، من أخشاب فاطمية تسبقه ، ما زال أثر زخارفها باقياً . وكذلك الأجزاء الباقية من التابوت الأيوبى الوارد من قبة الإمام الشافعى والمودعة بمتحف الفن الإسلامى ، فان عوارض الظهر بها من أخشاب منقوشة تسبقها . كما وأن عوارض تابوت أم الملك الكامل بقبة الإمام الشافعى من أخشاب فاطمية .

وها هو منبر الجامع الأقمر ، فانه حينما أمر بترميمه الأمير يلبغا السالمى أو غيره ، سطى النجار على حشوات الدواليب الفاطمية بالمسجد ، فأدمجها هى وبقايا حشوات المنبر الفاطمية فى العوارض من داخل المنبر وما زالت فيه إلى

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(١) المقريزى (المواعظ والاعتبار جزء ٢ ص ١٨٣)
(٢) المقريزى (المواعظ والاعتبار جزء ٢ ص ٣٠٠)

الآن ، كما حجب تواشيح باب المقدم بألواح خشبية بازالتها ظهرت النقوش الفاطمية .

وكذلك عثرنا على كثير من الأخشاب الفاطمية ، كانت مستعملة طَبْقاً لبعض السقوف أودعت متحف الفن الإسلامى ، وكذلك عثر على مصاريع مملوكية كاملة كانت مستعملة طبقاً لبعض السقوف اقتناها المرحوم على بك بهجت ضمن مجموعته الأثرية .

وعندما فتح الأشرف خليل بن قلاوون مدينة عكا سنة ٦٩٠ هجرية ١٢٩٠ ميلادية واستولى عليها ، نقل إلى مصر باباً رخامياً كان على كنيسة القديس يوحنا ، أدخله الملك العادل زين الدين كتبغا فى المدرسة التى بناها بالنحاسين ، والتى آلت إلى الناصر محمد بن قلاوون ، فأتمها ومحى اسم كتبغا من طرازها بالواجهة ، وكتب اسمه بحروف صغيرة ، وترك عليها تاريخ سنة ٦٩٥ هـ . ولم يكن الناصر فى الحكم وقتئذ .

وما أظنه فعل ذلك انتحالا ، ولكنه أقدم على ذلك لعدم اعترافه لكتبغا بالملك . وهذا ما فعله أيضاً مع بيبرس الجاشنكير من إزالته صفة الملك التى تسبق اسمه، من طراز واجهة خانقاه بيبرس الجاشنكير ، فقد محى منه كلمتى « الملك المظفر » وترك اسم بيبرس .

ويبدو أن المقريزى المؤرخ ، كان حانقاً على نقل المخلفات المعمارية من المساجد المتخربة ، والسطو عليها بأخذ أنقاضها بدلا من ترميمها ، فيقول عن جامع ابن المغربى الذى أنشأه صلاح الدين يوسف بن المغربى رئيس الأطباء بمصر أنه ظل عامراً بعمارة ما حوله . فلما تخرب خُط بركة قرموط تعطّل، وهو آيل للسقوط إلى أن ينقض ويباع كما بيعت أنقاض غيره[٢] .

وهو على حق فى هذا النقد ، ففى عهده وقعت اعتداءات من هذا النوع .

(١) حسن عبد الوهاب ، مجلة العمارة العدد ٧ و ٨ سنة ١٩٤١ (العمارة الإسلامية ، دولة المماليك البحرية « عصر الناصر محمد ») .

(٢) المواعظ والاعتبار للمقريزى جزء ٢ ص ٣٢٨



باب مدرسة الناصر محمد بن قلاوون بالنحاسين المنقول من كنيسة القديس يوحنا بعكا

فقد أخذ الملك الأشرف برسباى رخام قصر الأمير بيسرى لمدرسته بالأشرفية (١) . ووقعت من الأمير جمال الدين الأستادار ، اعتداءات على الآثار السابقة له وأخذ أنقاضها . فقد هدم مدرسة الأشرف شعبان التى كانت تحت القلعة ، وأخذ أنقاضها فى بناء مدرسته بالجمالية (٢) . وكذلك هدم مدرسة الأشرف خليل التى كانت تجاه القلعة وأخذ من أحجارها لبناء منارة كانت بالأزهر (٣) كما اعتدى أيضاً على المدرسة الصاحبية التى كانت بالفسطاط ، فأخذ عمدها فى سنة ٨١٣ هـ (٤) ١٤١٠ م .

ولكن الله كان له بالمرصاد ، فسلط عليه الناصر فرج بن برقوق سلطان وقته ، الذى عاقبه ومحا اسمه ورنكه من المدرسة الجمالية ووضع اسمه مكانه . وكذلك محا الأشرف برسباى اسم الأشرف شعبان من وكالة كانت بالركن المخلق وكتب اسمه عليها (٥) .

والحوادث كثيرة ومتعددة ، فيما يتعلق بانتهاز فرصة المساجد المتخربة وأخذ أنقاضها وإدخالها فى بناء مساجد أخرى . ومن ذلك ما فعله الشيخ أحمد الزاهد ، من أخذه مخلفات جامع الجاكى وإدخالها فى عمارة مسجده بالمقسى (٦) . ويعلق المقريزى على هذا عند ذكره هذا الجامع بقوله : « وهدم بسببه عدة مساجد قد خرب ما حولها وبنى بأنقاضها هذا الجامع (٧) . ومثله ما فعله الأمير طوغان الحسنى من أخذه العمد الرخامية من جامع الخندق إلى فسقية جامع آقسنقر (٨) .

وعندما شرع الملك المؤيد شيخ فى بناء مسجده سنة ٨١٩ هـ ١٤١٦ م طلبت عمد الرخام والألواح الرخامية للجامع ، فأخذت من الدور والمساجد وغيرها (٩) . ومنها عمودا المحـــراب فقد أخذهما من مسجد قوصون . ومثله

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(١) نزهة النفوس والأبدان للجوهرى ص ١١٤ خط .

(٢) المواعظ والاعتبار جزء ٢ ص ٤٠١ — (٣) المواعظ والاعتبار جزء ٢ ص ٢٧٦

(٤) المواعظ والاعتبار جزء ٢ ص ٣٧١ — (٥) المواعظ والاعتبار جزء ٢ ص ٢٧٦

(٦) المواعظ والاعتبار جزء ٢ ص ٣١٤ — (٧) المواعظ والاعتبار جزء ٢ ص ٣٢٨

(٨) المواعظ والاعتبار جزء ٢ ص ٣٢٥

(٩) المواعظ والاعتبار جزء ٢ ص ٣٢٨ والسلوك ١٣٣ جزء ٣ قسم ٢

السلطان الغورى عند بناء مدرسته سنة ٩١٠ هـ ١٥٠٤ م فانه هدم وخرب عدة قاعات وأخذ رخامها (١) .

وكذلك أخذ الشيخ الشرقاوى بعض أنقاض وعمد من مسجد الظاهر بيبرس بالظاهر إلى رواق الشراقوه (٢) بجوار الأزهر .

ولما أكل البحر بيعة بقطر جهة الجيزة ، أخذ منها والى مصر فخر الدين المعروف بغلام البنياسى ، ١٨ عموداً عليها رسم الصلبان عمر بها فندقاً (٣) .

ويكتنف محراب قبة مسجد قانبياى المحمدى بالصليبة المنشأ سنة ٨١٦ هـ ١٤١٣ م لوحان رخاميان منقولان من وزرة مدرسة صرغتمش وهى ألواح بها نقوش وكتابات جميلة . ووزرة هذه المدرسة مع أهميتها البالغة أسىء استعمالها ، فقد استعملت بعض ألواحها على وجهها الآخر فى أرضيات المسجد فاختفت نقوشها . وبعد كشفها نقلت إلى متحف الفن الإسلامى وأخيراً تبين انها منقولة من دار علم الدين ابن زنبور . كما وأن الأجناب الرخامية المكتوبة بالخط الكوفى فوق قبرى الملك المؤيد شيخ وخوند طولبية ، منقولة من أثار فاطمية .

لم يكن أخذ هذه المخلفات سواء أكانت من المساجد أو الكنائس المتخربة موضع استحسان أو رضاء ، فقد رأينا المقريزى عميد مؤرخى مصر ، ينتقده أكثر من مرة ، وسبقه بالحملة على هذا العمل صفوة علماء مصر . فقد حمل العلامة أبو الحسن الطحاوى على أبى بكر الخازن ، لما علم أنه أخذ عمداً من إحدى كنائس بلدان الجيزة (٤) وأدخلها فى بناء مسجد الجيزة وترك الصلاة فيه تورعاً ، وتصدى له العلامة العينى قائلا : أن الطحاوى كان يصلى فى جامع الفسطاط القديم (عمـــرو) وبعض عمده أو أكثرها ورخامه من كنائس الاسكندرية وأرياف مصر .

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(١) تاريخ المساجد الأثرية جزء ١ ص ٢٨٧

(٢) عجائب الآثار للجبرتى جزء ٤ ص ١٦٢ — ١٦٣

(٣) أبو صالح الأرمنى ص ٧٥ — (٤) المواعظ والاعتبار جزء ٢ ص ٣٢٠



لوح من الرخام عليه زخارف دقيقة وصور حيوانات
منقول من دار علم الدين بن زنبور إلى مدرسة صرغتمش بشارع الخضيرى

أقول أنه على حق ، لأن جميع عمد جامع عمرو وتيجانها ، منقولة من البيع والكنائس المتخربة . وعلى بعض تيجانها صلبان .

وكذلك قامت مشادة بين العلماء حول جواز الصلاة فى مسجد المنصور قلاوون ، لاغتصابه قاعة القطبية وتعسف الأمير علم الدين الشجاعى ، الذى كان مشرفاً على عمارته وتسخيره للناس فى البناء ، ووضعوا استفتاء نصه :

« ما يقول أئمة الدين فى موضع أخرج أهله منه كرهاً ، وعمر بمستحثين يعسفون الصناع ، وأخرب ماعمره الغير ، ونقل إليه ما كان فيه فعمر به . هل تجوز الصلاة فيه أم لا؟ فكتب جماعة من الفقهاء لاتجوز فيه الصلاة . وعزز هذه الفتوى الشيخ محمد المرجانى . وبعد إلحاح عليه قبل إلقاء درس فى المدرسة المنصورية حضره القضاة والعلماء والأمراء ، فألقى درساً حمل فيه على مغتصبى الأراضى ومسخرى العمال ، وختمه بقوله تعالى : « ويوم يعض الظالم على يديه يقول يا ليتنى اتخذت مع الرسول سبيلا ، ياويلتى ليتنى لم أتخذ فلاناً خليلا »[1] .

وهنا يفيض بالمقريزى ، فيعلق على هذا الخلاف بعد مضى حقبة طويلة عليه فيقول « إن كان التحرج من الصلاة لأجل أخذ الدار القطبية من أهلها بغير رضاهم ، وإخراجهم منها بتعسف ، واستعمال أنقاض القلعة بالروضة . فلعمرى ما تملك بنى أيوب الدار القطبية ، وبناؤهم قلعة الروضة وإخراجهم أهل القصور من قصورهم التى كانت بالقاهرة ، وإخراج سكان الروضة من مساكنهم ، إلا كأخذ قلاوون الدار المذكورة وبنائها بما هدمه من القلعة المذكورة وإخراج مؤنسة وعيالها من الدار القطبية ، وأنت إن أمعنت النظر وعرفت ما جرى ، تبين لك أن ما القوم إلا سارق من سارق وغاصب من غاصب . وإن كان التحرج من الصلاة لأجل عسف العمال وتسخير الرجال ، فشىء آخر . بالله عرفنى فانى غير عارف . من منهم لم يسلك هذا السبيل ؟ غير أن بعضهم أظلم من بعض[2] » .

(١) المواعظ والاعتبار جزء ٢ ص ٤٠٧ (٢) المواعظ والاعتبار جزء ٢ ص ٤٠٨

نكتفى بهذا القدر من نماذج الاعتداءات المتكررة المتلاحقة على الآثار بعد هذا التعليق الشافى الوافى .

والدارس للآثار الإسلامية بمصر ، لا يجد بين عناصرها فى البناء ما هو غريب عنها سوى العمد وتيجانها ، وبعض الأعتاب والعتبـــات المتخذة من الجرانيت الأسود والوردى ، بما عليها من كتابات هيروغليفية . وقد أشير إلى قسم من تلك العتبات فى كتاب الطبغرافية والنصوص المصرية القديمة والرسوم تأليف برتا بورنار وموس ، فذكرا فيه ما هو موجود منها فى خانقاه بيبرس الجاشنكير بالجمالية ، ومسجد عثمان كتخدا بميدان الأوبرا ، وقاعة الدردير بشارع الدردير ، وخانقاه شيخو بشارع الصليبة وغيرها من قطع وجدت فى أماكن غير أثرية نقل الكثير منها مع ما نعثر عليه بين آونة وأخرى إلى المتحف المصرى .

وأضيف إلى ما ذكر فى المؤلف المذكور ما وجدته ولم يشر إليه .

١ ــ عتبتين فى زاوية أحمد بن شعبان الأثرية بحارة المدرسة جهة الأزهر .

٢ ــ عتبة خانقاه الناصر فرج بن برقوق فى القرافة الشرقية .

٣ ــ عتبة مسجد مثقال الساقى بدرب قرمز بالجمالية .

٤ ــ عتبة مسجد آقسنقر بالتبانة .

٥ ــ عتبة مسجد خير بك بشارع باب الوزير .

٦ ــ عتبة باب مسجد آل ملك الجوكندار خلف المشهد الحسينى .

٧ ــ عتب مودع بمدخل قبة حسن صدقه بشارع السيوفية .

٨ ــ عتب مودع بمدخل مقعد الغورى بشارع الأزهر .

٩ ــ قطعتان من عمود مكتوب الأضلاع استعمل كقاعدة وتاج لعمود فى وكالة قوصون بشارع باب النصر بالجمالية . أودعتا المتحف المصرى عقب هدم الوكالة . ومن نوعها عمود فى جامع التركمانى بباب البحر .

١٠ــ عتبة باب التوفيق . المكتشف بالدراسة

١١ــ عتبة باب وكالة قوصون .

هذا عدا أشرطة رخامية خضراء هامة عثر عليها الزميل الدكتور حسن صبحى بكرى الأمين بالمتحف المصرى فى العام الماضى كانت مستعملة أشرطة



تاج عامود بالجامع الأزهر وعليه صورة نسر



تاج عامود عليه صليب منقول إلى جامع الصالح طلائع بن رزيك بميدان باب زويلة

فى كسوة محراب مسجد الخطيرى ببولاق عليها كتابات هيروغليفية هامة ، وعدا ضلع من تابوت رومانى استعمل فى أرضية مسجد السلطان حسن مودعاً الآن بمخازن الآثار العربية . وغير هذا كثير من أعتاب وتوابيت ما زال مبعثراً فى أقاليم مصر . ومنها تابوت هام كان فى مسجد الغمرى بميت غمر

والعنصر الثانى هو العمود والتاج وقد جمعت من المعابد المصرية والمسيحية المهدمة ، ومن المساجد المتخربة . وأن مجموعة التيجان الموجودة فى مساجد مصر ، حوت نماذج قيمة ونادرة من مختلف التيجان ، ومن بينها تيجان مصرية على مثال زهرة اللوتس ، وبعضها على شكل الزحف ، موجودة فى مسجد المارداني بشارع التبانة ، وفى مسجد سودون من زاده بسوق السلاح ، وقد نقلت إلى مخازن مصلحة الآثار ، ومقعد ماماى السيفى بميدان بيت القاضى . ومن بينها تيجان مسيحية رأيتها فى مساجد عمرو بن العاص ، والأزهر ، والصالح طلائع ابن رزيك بميدان باب زويلة . والمـاس بالحلمية ، والقاضى يحي ببولاق ، وتكية الرفاعية ببولاق ، ومسجد الأشرف برسباى بالخانكة ، وجانى بك بشارع القادرية ، واللمطى بالمنيـا ، ومدرسة المنصور قلاوون بالنحاسين ، وأبو غالية السكرى الذى كان بالمحجر وهدم ، والمؤيد شيخ بالسكرية . وفى حمام سمنود ، ومسجد أحمد حسن بادكو .

وهذه التيجان منها ما هو منقوش عليه الصليب ، ومنها ما هو منقوش عليه حمامة أو نسر ، ومنها ما جمع بين الاثنين ، وهى رموز مسيحية . والكثير من التيجان المشتملة على الصليب ترك الصليب فيها كاملا ، وفى البعض الآخر كسر ضلع منه ، كما كسرت رأس النسر أو الحمامة أحياناً وأحياناً تركت كاملة .

ومن الطريف أن نجد بين المؤرخين من ينظر إلى الحمامة أو النسر كطلسم . فيقول المقريزى على ما وجد منها فى الجامع الأزهر « أنه يوجد به طلسم فلا يسكنه عصفور ولا يفرخ به وكذا سائر الطيور من الحمام واليمام وغيره وهو صور ثلاثة طيور منقوشة كل صورة على رأس عمود ، وحدد موضعها [1] .

(١) خطط المقريزى جزء ٢ ص ٢٧٣

وهذا القول وإن كان من قبيل الخرافة ، إلا أنى وفقت إلى حله والعثور على الطيور الثلاثة والطير الرابع فى تيجان العمد . ومنها ما هو موجود مع الصليب ، مثل التاج الموجود بصحن الجامع أمام رواق المغاربة .

وبين مجموعة العمد عمد ضخمة من الجرانيت المنقولة من المعابد المصرية [1] ، مثل العمد الكبيرة الموجودة فى قبة المنصور قلاوون ، والمنقولة إليها من القلعة الصالحية ، والتى كانت قبل ذلك فى البرابى ونقلت إليها ثم إلى دار العـدل ومسجد الناصر بالقلعة ، ويوجد غيرها فى مساجد الماردانى وعثمان كتخدا ، وما كان منها فى مسجد اسكندر باشا الذى كان وسط باب الخلق وأعيد استعمالها فى جامع الفتح بعابدين عند تجديده ، وباقيها أقيم على مدخل ساحة رياضية خلف جامع المؤيد . ومن بين العمد المنقولة ، عمود رخامى عليه كتابة يونانية مسيحية فى دكة المبلغ بمسجد عثمان كتخدا بميدان الأوبرا .

وعلى ذكر الكتابات اليونانية ، أذكر أنه يوجد فى سلم جامع قفط قطعة رخامية عليها كتابة يونانية ترجمها الزميلان يسى عبد المسيح ورءوف حبيب وقالا بأنها ترجع إلى القرن الثانى للميلاد ، وعليها اسم ماركوس أوريليوس وأسماء أخرى منها كرياكوس .

ومن التفاصيل الهامة المنقولة، ذلك الباب الجرانيتى المنقول إلى مشهد الامام زين العابدين فى سنة ٥٤٩ هـ ١١٥٤ م فانه مصراع من قطعة واحدة يبلغ ارتفاعه نحو ١٨٠ × ١٢٠ سم وله عقب وسكرجة وحلق جرانيتى محيط به . ولعله الباب الوحيد من نوعه بين آثار مصر ، وهذا النوع يكثر فى بادية الشام . وفى مسجد اللمطى بالمنيا اتخذ جانبا الباب وعتبه من آثار مصرية ورومانية كما اتخذ جانبا مدخل جامع المؤيد من الجرانيت الوردى المرقط ، وفى مسجد الحلوتى محراب من قطعة واحدة من الجرانيت الأسود كانت غطاء لتابوت .

هذه هى العناصر الغريبة التى أدمجت فى الآثار الإسلامية بمصر . أما ما عدا ذلك من الآثار المنقولة فهى غالباً من آثار إسلامية إلى إسلامية ومن

(١) خطط المقريزى جزء ٢ ص ١٨٤

العمد الجرانيتية بتيجانها المصرية المنقولة إلى جامع الماردانى بالدرب الأحمر

ذلك ما نقله الحجاج عند بنائه مدينة واسط من الأبواب المصفحة بالحديد التى كانت لمدينة الزندورد لتركيبها بها ثم أخذها أبو جعفر المنصور عند بناء مدينة بغداد وركبها على أبوابها عدا باب خراسان الخارجى فانه أحضر له باباً من الشام من عمل الفراعنة — وكذلك ركب على باب الكوفة الخارجى باباً جيء به من الكوفة كان عمله خالد بن عبد الله التسترى (١) ، وكذلك نقل القائد جوهر الصقلى باباً حديدياً كان على ميدان الإخشيد وركبه على باب الخندق وذلك فى سنة ٣٦٠ هـ (٢) ٩٧٠ م ، وكذلك نقل صلاح الدين المغربى باب الميدان الصالحى الذى كان بأرض اللوق إلى قيسارية الغزل (٣) . وأيضاً فقد نقل السلطان بيبرس البندقدارى فى سنة ٦٦٩ هـ أحد أبواب القصور الفاطمية إلى الخان الذى أنشأه بأطراف القدس (٤) .

هذا جزء مما حدثنا عنه التاريخ ، أما التفاصيل الكاملة المنقولة من مكان إلى مكان فى آثار مصر ، وما زالت باقية فيها ، فانها هامة وعلى جانب عظيم من الأهمية ، سأذكرها . حسب أنواعها .

١ — باب من قبة الإمام الشافعى .

هذا الباب نقل إلى مسجد الإمام الليث وركب على الباب الذى جدده السلطان الغورى بالمسجد ، وهو من مصراعين دقت حشواتهما الخشبية بأويمة دقيقة وهو صنو للباب الموجود على قبة الإمام الشافعى فى الصناعة والمقاس والكتابة ، إذ نقرأ على كل منهما أبياتاً من الشعر فى مدح الإمام الشافعى وتاريخ سنة ٦٠٨ هـ (٥) ١٢١١ م .

٢ — مصراعا باب المدرسة الظاهرية .

هذا الباب كان مركباً على المدخل الرئيسى للمدرسة الظاهرية أمام قبة المنصور قلاوون قبل هدمها ، ثم نقل إلى السفارة الفرنسية فى مقرها القديم

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(١) تاريخ الرسل والملوك للطبرى جزء ٩ ص ٢٦١
(٢) المواعظ والاعتبار جزء ٢ ص ١٩٧ (٣) المواعظ والاعتبار جزء ٢ ص ١٩٨
(٤) أنس الجليل جزء ٢ ص ٤٣٤ (٥) تاريخ المساجد الأثرية جزء ١ ص ١١٢



غطاء تابوت من الجرانيت
مستعمل محراب فى جامع الخلوتى بشارع البرمونى

محل عمارة الإيموبيليا ونقلته معها إلى مقرها الجديد بالجيزة ، وهو باب موشى بالنحاس المفرغ بأشكال زخرفية ، وعليه اسم الظاهر بيبرس وتاريخ سنة ٦٦١ هجرية بالأرقام الهندية ، ولعله أقدم نموذج لكتابة التاريخ بتلك الأرقام فى الآثار الإسلامية بمصر ، يليه التاريخ المرقوم فى الجص بطراز قبة حسن صدقة بالسيوفية سنة ٧٢١ هـ ١٣٢١ م .

٣ — مصراعا باب المدرسة المنكوتمريه .

هذان المصراعان مركبان على باب المدرسة المزهرية بشارع البغـال والمنشأة فى القرن الخامس عشر الميلادى وتتفق صناعتهما مع صناعة باب المدرسة المنصورية ، فهما مكونان من حشوات نحاسية مفرغة بأشكال زخرفية لفت نظرى فيهما دقة صناعتهما ومخالفتها لصناعة القرن الخامس عشر ، كما وأن المصراعان أكثر ارتفاعاً من فتحة باب المسجد. ومن دراسته تبين أنه مكتوب برأس المصراعين ما نصه (مما عمل برسم الجناب الكريم العالى المولوى الأسفهلارى سيف الدين منكوتمر المنصورى أعز الله أنصاره وضاعف اقتداره ونصره .

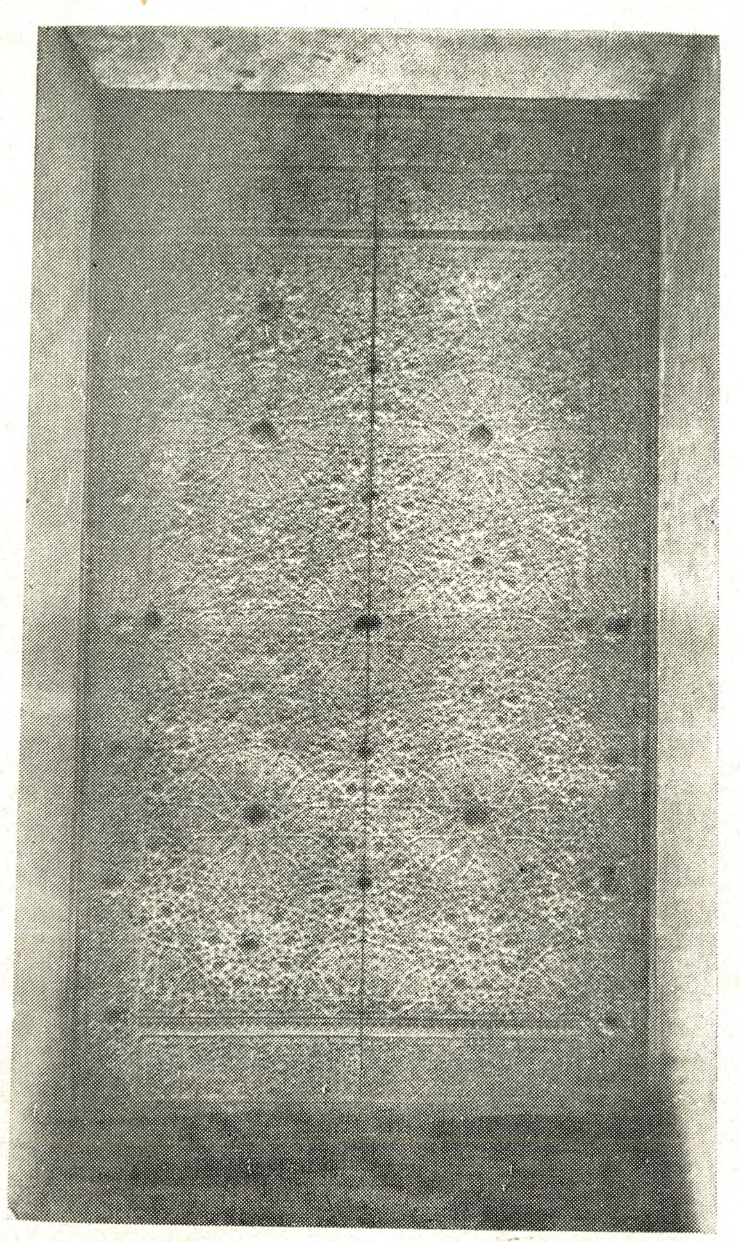
إذاً فهما مصراعا باب المدرسة المنكوتمرية التى كانت بحارة بهاء الدين ، والتى أنشأها الأمير منكوتمر الحسامى المنصورى نائب السلطنة سنة ٦٩٨ هجرية ١٢٩٦ ميلادية (١) .

كما وأن الزخارف الرخامية فى هذا الباب منقولة إليه من المدرسة المذكورة .

٤ — كرسى المصحف بمسجد قوص .

عثرت على هذا الكرسى بمسجد قوص الذى أنشأه الصالح طلائع بن رزيك سنة ٥٥٠ هجرية مستعملا كتابوت عليه ستر ومقاسه ١,٣٠ × ٥٥ سم ، وبالكشف عليه تبين أنه كرسى مصحف مكون من حشوات مسدسة خالية من الأويمة ، ومكتوب بجوانبه آية الكـرسى ثم ما نصه ، أمر بانشاء هذا المصحف المبارك المقر الكريم العالى المولوى الأميرى الأجلى عز الدين خليل

(١) المواعظ والاعتبار جزء ٢ ص ٣٨٧



مصراعا باب مدرسة الظاهر بيبرس البندقدارى المنقول إلى السفارة الفرنسية



مصراعا باب قصر شمس الدين سنقر الطويل
المنقولان إلى مسجد الأشرف برسباى بالخانكاه
ومودعان الآن بمتحف الفن الإسلامى

الملكى الناصرى أعز الله أنصاره بمحمد وآله ، وبوسط كل جانب رنك (هدف النبلة) فلعل الأمير خليل عمله للمسجد وهو ما لم يرد فى تاريخ المسجد أو منقول إليه من أثر آخر .

٥ — مصراعا باب قصر شمس الدين سنقر الطويل .

من المصاريع النحاسية المحفوظة بمتحف الفن الإسلامى ، ومكتوب عليهما اسم صاحب القصر شمس الدين سنقر الطويل المنصورى ، أحد أمراء المنصور قلاوون فى آخر القرن الثالث عشر الميلادى . كان هذا الباب فى مسجد الأشرف برسباى بالخانقاه ، وقد بحثه أستاذنا المغفور له على بك بهجت وكتب عنه بحثاً قيما نشر فى مجلة المجمع العلمى المصرى سنة ١٩١٥ . وهو من أجمل الأبواب وأدقها صناعة ، فقد حوى نقوشاً دقيقة مفرغة فى النحاس تخللتها صور وطيور .

٦ — مصراعان من مدرسة السلطان حسن .

هما فخر المصاريع النحاسية وأجملها وأكبرها ، عملا خصيصاً لمدرسة السلطان حسن ، وما زال عليهما اسمه وتاريخ سنة ٧٦٤ هـ ، نقلهما الملك المؤيد شيخ إلى مسجده فى سنة ٨١٩ هـ فقد انتهز فرصة غلق المدرسة لمنع مهاجمة القلعة من سطوحها ونقلها إلى مسجده بالسكرية ، وما زالا به إلى الآن .

٧ — مصراعا باب مسجد داود باشا بسويقة اللالا .

هذا المسجد منشأ سنة ٩٥٥ هـ ١٥٤٨ م ومركب على الباب مصراعان من الخشب بتقاسيم فريدة فى نوعها وحشوات مدقوقة أويمة دقيقة فى الخشب والسن ، وبه من أعلا وأسفل جامات نحاسية .

ان دقة صناعة الحفر فى حشوات المصراعين ترجع بهما إلى القرن الثامن الهجرى الرابع عشر الميلادى ، خصوصاً وأن تلك الجامات لها مثيل فى باب قبة مسجد ألماس سنة ٧٣٠ هـ ١٣٣٠ م .



مصراعا باب المدرسة المنكوتمرية المنقول إلى المدرسة المزهرية بشارع البغال

وكذلك يوجد ضمن شبابيك المسجد مصراعا شباك ، حشواتهما السن والخشب مدقوقة أويمة دقيقة ترجع إلى القرن الرابع عشر الميلادى . ولا شك أنهما منقولان مع الباب من آثار مملوكية ، لان تلك الصناعة الدقيقة لا تتفق وعصر المسجد .

٨ — باب سبيل الكردى .

هـــذا الباب يوجد فى سبيل الكـــردى بدرب الجماميز المنشأ فى القرن الحادى عشر ، وهو باب مملوكى حشواته مطعمة ومدقوقة أويمة منقول إليه . ومثله باب بمنزل السحيمى من مصراع واحد مطعم بالسن وبالزردشان من صناعة القرن الخامس عشر ، كان مركباً بالقاعة القبلية ونقل إلى باب الخزنة بالقاعة البحرية ، وصناعته دقيقة لا تتفق وعصر المنزل ، مما يعزز نقله من أثر مملوكى .

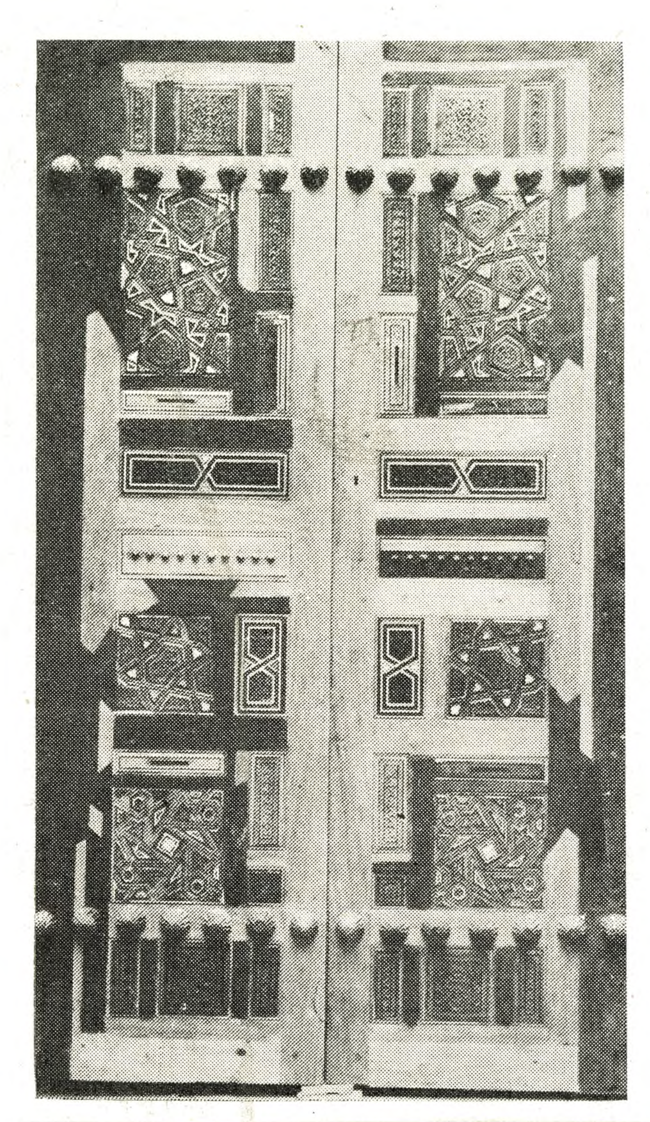
٩ — شباك نحاسى مكفت بالذهب والفضة .

هذا الشباك ، مكون من رماح ومخرزات خشبية ، ملبسة بالنحاس كان ، مركباً فى شباك علوى بمدخل مسجد شيخو ، وقد كساه الصدأ . ولعدم انسجامه فى الوضع الذى كان به ، رفع من مكانه تمهيداً لإرساله إلى المخزن . وقد لفت نظرى إليه خفة وزنه وأثر زخرف طفيف دعانى إلى كشفه فأسفر الكشف عن أن الرماح مكفتة بفرع زخرفى من الفضة ، وأن وجه المخرزة مكفت بالذهب ، ومكتوب فيه الملك المظفر .

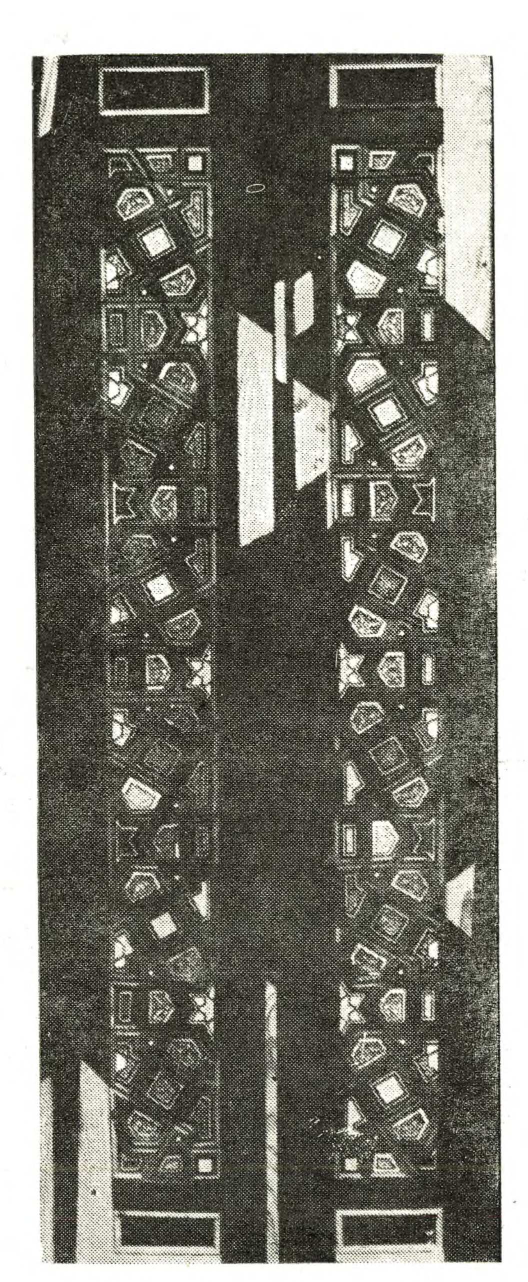
وهذا الشباك وإن كان معاصراً للمسجد ، إلا أن وضعه فى الوضع الغير لائق به ، والذى لا يظهر محاسنه وقيمته ، لا يدع مجالا للشك فى أنه منقول من منشأة تحمل اسم الملك المظفر حاجى (وهو الآن مودع متحف الفن الإسلامى) .

١٠ — هلال منارة مسجد البردينى بالداودية .

هذه المنارة أنشئت سنة ١٠٣٨ هـ ١٦٢٨ م ، وهى منارة رشيقة متأثرة بالمنارات المملوكية . قامت مصلحة الآثار بفكها وإعادة بنائها فى سنة ١٩٥٥



مصراعان من العصر المملوكي منقولان إلى مسجد داوود باشا بسويقة اللالا



مصراعان مطعمان بالسن من العصر المملوكي
منقولان الى مسجد داوود باشا

لميل ظهر بها ، وقد ظهر للزميل السيد عباس بدر كبير مهنـــدسى الآثار الإسلامية أن الهلال مكون من قطع نحاسية عليها نقوش وكتابات . وبدراستها وقراءتها تبين لى أن الهلال مكوناً من مشكاة نحاسية مكفتة بالفضة مكتوب عليها فى المنطقة العليا ألقاب منها، المقر الأشرف العالى المولوى الأميرى ... ، تتخللها دوائر يقرأ فيها فى المنطقة العليا ، الملك المظفر ، وبالوسط قوله تعالى : « كوكب درى يوقد من شجرة مباركة » .

والمظفر نسبة إلى أحد اثنين : الملك المظفر بيبرس الجاشنكير ، والملك المظفر حاجى بن الناصر محمد بن قلاوون سنة ٧٤٧ هـ وهو ما أرجحه . وبقية الهلال من قطع أسطوانية بها بقايا زخارف وكتابات ، ومكتوب على الهلال بخط نسخى ، الفقير كريم الدين البرديني .

١١ — هلال القبة البحرية لخانقاه فرج بن برقوق .

عند إصلاح القبة البحرية لخانقاه فرج بن برقوق ، ظهر أن الهلال مكون من عدة قطع قديمة عليها كتابات ورنوك ، منها ثلاث صدريات كبيرة مملوكية فرّغ قاعها وركب فيه وصلات من شمعدانات قديمة علاها الصدأ ، يقرأ على أحد الصدريات ، المقر العالى المولوى أمير الأمراء الكبير المالكى العابدى المجاهدى المرابطى المشاغرى المؤيدى الملكى الناصرى . وعلى بعض الأجزاء الأسطوانية رنك كأس ، ويقرأ عليها :

مما عمل برسم المقر الأشرف العالى المولوى الأميرى الكبير المخدومى .... ، وعلى آخر :— مما عمل برسم الجناب العالى الملكى العالمى علم الدين ...

وقد أودعت متحف الفن الإسلامى لنظافتها ودراستها وتكملة قراءتها .

وهناك آثار منقولة بالاختيار ، ما بين منابر وكراسى ، أمثال :

١ — منبر مسجد كاتم السر :

كان هذا المنبر فى مسجد كاتم السر ، الذى كان على الخليج بدرب الجاميز وعند تجديده أصلحته إدارة حفظ الآثار العربية فى سنة ١٩٠٧ ،



تفاصيل من الشباك النحاسى باسم الملك المظفر المكفت بالذهب والفضة — المنقول إلى مسجد شيخو بالصليبة

ووضعته بالقبة الفداوية حينما أعدّتها للصلاة . وهو منبر صغير طعمت حشواته بالسن والأبنوس ، وترجع صناعته إلى القرن الخامس عشر ، وينسجم مع عصر الأثر الذى نقل إليه .

٢ — منبر مسجد فرشوط :

هذا المنبر من المنابر الهامة ، حشواته الخشبية مدقوقة بأويمة جميلة ، وعليه اسم صانعه « يعقوب بن بركات الهوى » وترجع صناعته إلى القرن الرابع عشر الميلادى ، واعتبره فريد فى نوعه ، لوقوع تأثيرات أندلسية على حشواته المتنوعة .

كان هذا المنبر فى مسجد فرشوط ، ثم أصلحته لجنة حفظ الآثار العربية ونقلته إلى مسجد الظاهر بيبرس البندقدارى بالقاهرة .

٣ — منبر وكرسى السورة لمسجد الغمرى :

بعد أن تخرب جامع الغمرى بشارع أمير الجيوش ، أهمل المنبر ووصل إلى حالة سيئة ، ونظراً لأهميته عنيت به إدارة حفظ الآثار العربية فأصلحته هو وكرسى المصحف ونقلته إلى مصلى مدفن الأشرف برسباى بالصحراء لحاجتها إليه ومعاصرته لها ، وهو منبر جميل طعمت حشواته بالسن والزرنشان والأويمة برسوم جميلة ميزته على كثير من المنابر المعاصرة له ، ومعلوم أن الآمر بعمله هو والكرسى محمد بن على المعروف بابن الردادى سنة ٨٥٠ هـ ، ١٤٤٦م وصانعه هو النجار الماهر أحمد بن عيسى الدمياطى [1] ثم القاهرى .

٤ — كرسى السورة لمسجد قجماس الإسحاقى :

من أجمل الكراسى المطعمة بالسن ، نقلته وزارة الأوقاف إلى مسجد الفتح بعابدين .

٥ — منبر مسجد أزبك من ططخ :

هذا المسجد كان بميدان العتبة الخضراء بمدخل الموسكى ، وبمنشئه

(١) تاريخ المساجد الأثرية جزء ١ ص ٢٢٨

عرفت الأزبكية ، وقد هدمت بقاياه سنة ١٢٨٦ هـ ١٨٦٩ م ونقل منبره الذى كان به إلى المشهد الحسينى بعد الفراغ من تجديده سنة ١٢٩٠ هـ ، ١٨٧٣ م .

القـــاشـــانى :

لوحظ أن الكثير من ألواح القاشانى لم تعمل خصيصاً للأثر الموجودة فيه اللهم إلا القليل ، وبعضه عمل خصيصاً لها مثل الموجود فى مسجد أقسنقر (ابراهيم أغا) والموجود فى سبيلى عبد الرحمن كتخدا والسلطان محمود وقاعة السادات ، أما غالب الأماكن الموجود بها قاشانى فهو منقول إليها من آثار أخرى . على أن أكبر مجموعة منقولة وأهمها تلك المجموعة المتباينة التى ألصقت بغير وعى ولا ذوق فى الواجهة البحرية لقبة الجلشنى بشارع أحمد ماهر ، وهى قبة أنشئت فى سنة ٩٣١ هـ وكسيت وجهتها بهذا القاشانى فى سنة ١٢٥١ هـ ١٨٣٥ م . وقد حوت تلك المجموعة تفاصيل متباينة من قاشانى رودس وتركيا جمعت مختلف الرسوم والألوان والأحجام وهى غير منسجمة مع بعضها ، وحبذا لو فكت ونسقت وأودعت متحف الفن الإسلامى .

الآثار المنتحلة

١ — باب مسجد الإمام الليث :

هذا الباب فى الجهة الشرقية للمسجد محلى من جانبيه بكتابات نسخية يتخللها زخرف ، ومكتوب على عتبه (جدد هذا المقام المبارك فى أيام سيدنا ومولانا السلطان الأعظم الملك الظاهر محمد عز نصره على يد الفقير إلى الله تعـــالى أبو بكر بن يونس شيخ القرافتين الصوفى خادم الإمامين الشافعى والليث ابن سعد لطف الله به فى المحرم عام أحد عشر وثمانمائة) .

هذا الباب بزخرفه وطرز كتابته بجانبيه يرجع إلى العمارة التى أجريت بالمسجد سنة ٦٤٠ هـ ، ١٢٤٢ م ، ثم كتب على عتب غير عتبه القديم تاريخ العمارة التى أمر بها الناصر فرج بن برقوق سنة ٨١١ هـ باشراف الشيخ أبو الخير محمد بن الشيخ سليمان المادح ، وهى العمارة التى حدثنا عنها المقريزى . غير أن

النص الحالى يغايرها ، ذلك أنه تراءى للشيخ أبو بكر بن يونس أن يمحو اسم سلفه المادح ويمحو معه اسم الناصر ويضع اسمه واسم سلطان وقته الظاهر محمد أبو سعيـــد جقمق فمحى من السطر الأول كلمتى الناصر فرج وأصلحها وجعلها الظاهر وكتب محمد حشراً[1] ثم محى من السطر الثانى اسم سلفه كما يبدو من اختلاف خطه وغوره وكتب فيه اسمه أبو بكر بن يونس وترك التاريخ الأصلى فى آخر اللوحة سنة ٨١١ هـ فنم عن هذا التزوير ، لأن الظاهر أبو سعيد حكم من سنة ٨٤٢ إلى ٨٥٧ هـ . ١٤٣٨ – ١٤٥٣ م .

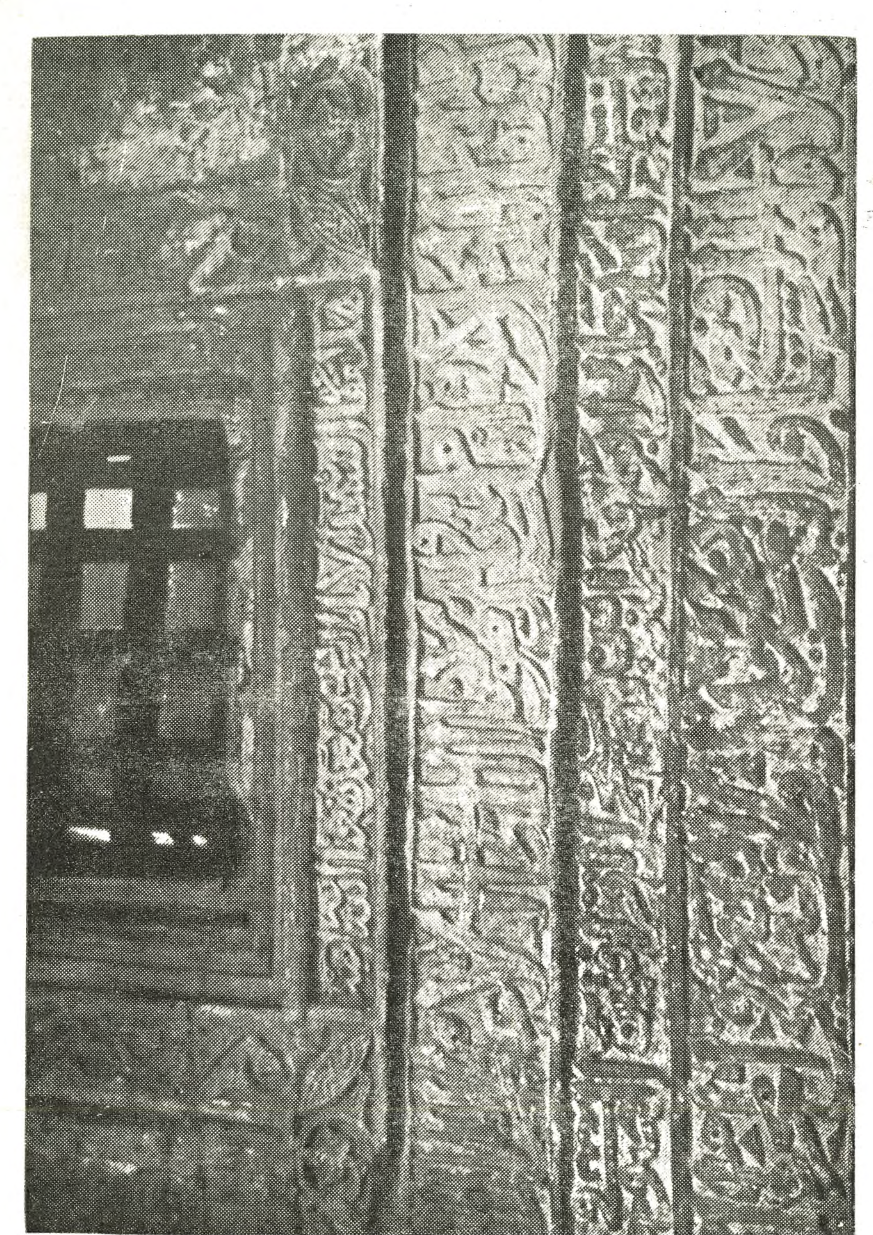
٢ – صندوق المصحف المنسوب إلى سيدنا عثمان بالمشهد الحسينى :

هذا الصندوق من خشب مغلف بجلد ، مخرم بأشكال هندسية منكرة بالذهب . وله مفصلات مذهبة عليها اسم السلطان الغورى بما نصه : « برسم المصحف الشريف العثمانى ، السلطان الملك الأشرف قانصوه الغورى » .

ومكتوب على أحد وجهى الغلاف مانصه : « جدد هذا المصحف الشريف المعظم الذى من إذا حلف به صادقاً نجا وكان له من كل ضيق مخرجاً ومن حلف به فاجراً كف وهان وأصبح فى ذل ومقت وخذلان بخط من رتب سوره وآياته وأجزائه ومن ختمه فى كل ركعة من صلاته وبه اقتدى من سماه نبينا بالأمين ذى النورين زوج بنتيه ورفيقه فى الدارين من استحيت منه ملائكة الرحمن أمير المؤمنين عثمان بن عفان أمر وتشرف بتجليده السلطان الملك الأشرف قانصوه الغورى كان الله له وتجديده على يديه بعد ثمانمائة وأربع وسبعون عاماً مضت تقبل الله ذلك منه ببركته وحفظه ونصره وثبت قواعد دولته بمحمد وآله)[2] .

ويلاحظ فى هذه الكتابة أن جملة (السلطان الملك الأشرف قانصوه الغورى كان ..) مكتوبة بخط مغاير لبقية الكتابة ، مما يؤكد أن القائم بعمل هذا الصندوق غيره ولعله السلطان قايتباى لاتفاق التاريخ مع عصره ، وأن السلطان الغورى أصلحه وعمل له مفصلات ثم غير الكتابة وكتب اسمه عليه .

(١) تاريخ المساجد الأثرية جزء ١ ص ١٩٩ (٢) تاريخ المساجد الأثرية جزء ١ ص ٩٣



باب مسجد الإمام الليث ويظهر فى السطر الأوسط أثر التغيير فى الكتابة

أما الزعم بأنه مصحف عثمان فهو زعم منقوض لأسباب كثيرة . أهمها : قاعدة الخط والزخرف فانها لا تتفق والقرن الأول وأيضاً فان نسبة مصحف عثمان لازمت كثيراً من المصاحف الموجودة فى مصر وفى قرطبة وبلاد المغرب وفى الشام والحجاز ، ولم يثبت أن عثمان رضى الله عنه كتب بخطه مصحفاً .

قبـــة بدر الجمالى :

وهناك آثار انتحلت من غير قصد للجهل بأسماء منشئيها ولغلبة أسماء جديدة عليها ، مثل قبة بدر الجمالى خارج باب النصر بشارع نجم الدين ، فقد عرفت بالشيخ يونس السعدى ، وهى فى الحقيقة قبة بدر الجمالى وزير الخليفة المستنصر بالله لأن المعروف أن تربته هى أول[1] تربة بنيت فى تلك المنطقة دفن فيها سنة ٤٨٧ هـ ١٠٩٤ م فعرفت به ، كما عرفت بابنه الأفضل شاهنشاه لأنه لما توفى سنة ٥١٥ هـ ١١٢١ م دفن مع أبيه . ومن بحث القبـــة ومقرنصاتها وعقودها والكتابة الكوفية حول عقد المحراب تبين لى أنها ترجع إلى منشآت النصف الثانى من القرن الخامس الهجرى وأصبح الترجيح إلى حد بعيد أنها قبة بدر الجمالى وابنه الأفضل شاهنشاه ، وتاريخ إنشائها حوالى سنة ٤٨٠ هـ — ١٠٨٧ م .

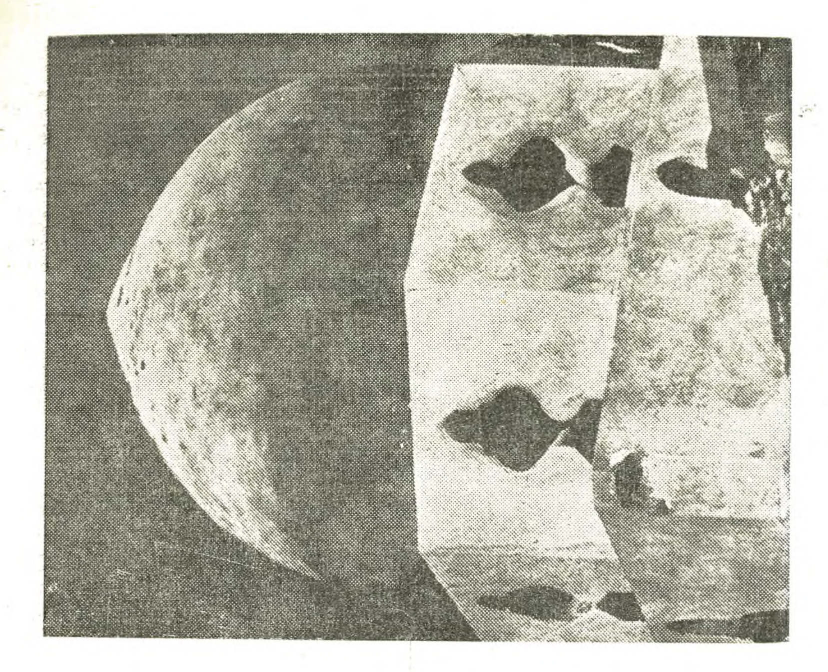
قبـــة يونس الدوادار :

هذه القبة بحرى خانقاه فرج بن برقوق بصحراء قايتباى ، وهى معروفة باسم أنس والد برقوق لأنه مكتوب على عتب الشباك ما نصه : بسم الله الرحمن الرحيم . لما كان بتاريخ يوم السبت ١٨ شوال سنة ٧٨٣ توفى المقر المرحوم الشرفى أنس تغمده الله برحمته والد المقر الأشرف العالى السيفى برقوق أتابك العساكر عز نصره .

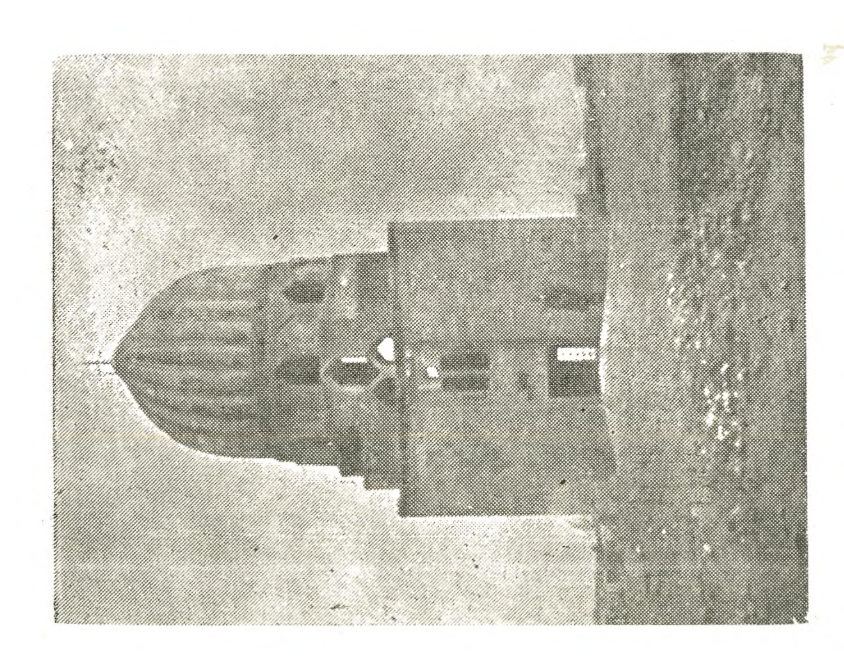
والحقيقة أن هذه القبـــة مخلفة من الخانقاه التى أنشأها الأمير يونس الدوادار قبل سنة ٧٨٣ هـ — ١٣٨١ م فقد ذكر المؤرخون[2] أنه لما توفى

(١) المقريزى جزء ٢ ص ٤٦٣ وابن ميسر ص ٥٨

(٢) المنهل الصافى جزء ١ ص ٢٩٦ خط وأنباء الغمر .



قبة بدر الجمالى خارج باب النصر المعروفة خطأ باسم الشيخ يونس



قبة يونس الدوادار بالقرافة الشرقية المنسوبة خطأ إلى أنس والد برقوق

أنس والد برقوق دفن فى تربة يونس الدوادار ثم نقله ابنه الظاهر برقوق إلى قبة مدرسته بالنحاسين .

قبـــة عبد الله المنوفى :

هى قبة صغيرة فى صحراء قايتباى عرفت بالشيخ عبد الله المنوفى الصوفى المتوفى سنة ٧٤٩ هـ — ١٣٤٨ م والمدفون تحتها ، وهى وإن كانت معروفة بهذا الإسم إلا أن منشئها السلطان قايتباى حوالى[١] سنة ٨٧٩ هـ — ١٤٧٤ م .

مسجد الملكة صفية سنة ١٠١٩ هـ ١٦١٠ م :

نسب هذا المسجد إلى الملكة صفية زوجة السلطان مراد الثالث وهى لم تحضر إلى مصر ولم تأمر بانشاء المسجد ، والحقيقة أن منشئه هو عثمان أغا ابن عبد الله أغات دار السعادة مملوك الملكة صفية ولما مات استولت هى على المسجد وعلى الأعيان المرصودة عليه باعتباره مملوكاً لها بالرغم من دفع موكله بأنها أعتقته قبل وفاته ، ولكن[٢] حكم لها وعرف المسجد باسمها .

خان الزراكشة :

هذا الخان بميدان الجامع الأزهر ويلاصق مسجد محمد بك أبو الذهب من الجهة الغربية البحرية . ظل ردحاً طويلا مسجلا باسم وكالة أبو الذهب مع أن تفاصيله المعمارية تبرئه من تلك النسبة . وقد أسفرت دراسته الفنية عن أنه من أبنية مستهل القرن السادس عشر خصوصاً وأنه وارد فى[٣] وقفية مسجد محمد بك أبو الذهب بهذا الإسم عند ذكر حدود المسجد وأنه من ممتلكات السلطان الغورى . وقد عثر الزميل الدكتور عبد اللطيف ابراهيم على اسم الخان فى حجج أواخر القرن الخامس عشر مما يجعله من منشآت عصر السلطان قايتباى .

آثار شبه منتحلة :

توجد آثار أخرى شبه منتحلة أطلق عليها أسماء أفراد لا أثر لهم فى إنشائها

(١) الضوء اللامع ٦٢ جزء ٤ قسم ٢ خط .
(٢) تاريخ المساجد الأثرية جزء ١ ص ٣٠٧
(٣) حجة مسجد أبو الذهب .



خان الزراكشة بميدان الأزهر — وكان منسوباً إلى أبى الذهب بينما هو من منشئآت عصر السلطان قايتباى — أواخر القرن التاسع الهجرى — الخامس عشر الميلادى

وإن كانت قد أقيمت فى عهدهم ، فقد كتب القاضى يحيى زين الدين اسم السلطان الظاهر محمد أبو سعيد جقمق على مسجديه بالحبانية وبولاق بما نصه : أنشأ هذا الجامع المبارك فى صحايف مولانا السلطان الملك الظاهر محمد أبو سعيد جقمق عُز نصره فقير رحمة ربه أبو زكريا يحيى الشافعى . كما يلاحظ أيضاً أن اسم الظاهر جقمق مكتوب على المسجد الذى أنشأه لاشين اللالا ٨٥٤ هـ — ١٤٥٠ م بشارع مراسينا ، وعلى المدرسة الفخرية التى جدد إنشاءها ناظر الخاص الجمالى يوسف سنة ٨٥٥هـ(٢) — ١٤٥١م . مع أنه لم ينشئهما .

ورغم هذا فان المساجد عرفت بأسماء منشئيها عدا المدرسة الفخرية بالحمزاوى فانها ظلت معروفة باسم جقمق، ولهذا الانتحال بالاختبار سبب، ذلك أنه بعد تولية الظاهر جقمق مُلك مصر رغب فى أن يتسمى بمحمد تشرفاً ثم تراءى له أن يجمع بين الإسمين ، فأمر بأن يكتب اسمه على أبواب المساجد المجددة والمنشأة فى عصره ، ويحدثنا السخاوى(٣) بأنه كان يرى إصلاح ما يشرف على الهدم أولى من الإنشاء ولذلك لم ينشىء مدرسة ولا تربة .

سبيل وكتاب السلطان قايتباى :

عهدنا بالسلطان قايتباى محباً للعمارة مسرفاً فى إنشاء المساجد والمدارس(١) فى مصر والشام والحجاز ، ومن بين منشآته ذلك السبيل اللطيف الذى يعلوه الكتاب بأول شارع الصليبة المكتوب عليه اسمه وتاريخ الفراغ من بنائه ، وهو ثانى سبيل يعلوه كتاب ينشئه منفرداً. حدثنا ابن إياس عن إنشاء هذا السبيل باضطراب فيقول فى حوادث سنة ٨٨٤ هـ — ١٤٧٩ م أن السلطان قايتباى كشف على عمارة سبيله الذى أنشأه برأس سويقة منعم بالرميلة وكان الشاد (المشرف على عمارته)(٤) تانى بك قرا .

ثم يقول فى حوادث سنة ٩٠٥ هـ — ١٤٩٩ م عند ذكر وفاة الأمير

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(١) تاريخ المساجد الأثرية جزء ١ ص ٢٤٠ — ٢٤١
(٢) التبر المسبوك ص ١١٦ (٣) الضوء اللامع جزء ٣ ص ٧٣
(٤) تاريخ مصر لابن إياس جزء ٢ ص ١٩٤

تانى بك بالقدس « ومن آثاره السبيل والصهريج الذى أنشأهما برأس سويقة ابن عبد المنعم وصرف على ذلك من ماله ما له صورة . فلما كمل بناء ذلك قدم السبيل والصهريج للسلطان قايتباى(١) »

وإنى لاأميل إلى الأخذ برواية ابن إياس ولو أنه معاصرا . لأن السلطان قايتباى أنشأ مجموعة هامة من الآثار عهد بالإشراف على تنفيذها إلى عدد من الأمراء لم نسمع أن أحدهم وهبه منشأة دينية أو مدنية ، هذا من جهة . ومن جهة أخرى فان شاد العمارة موظفاً صغيراً لا تسمح له موارده بانشاء مثل هذا السبيل . وفى الوقت نفسه نرى ابن إياس يناقض نفسه فى روايتين . وإنى أنزه قايتباى وأعتبر هذا السبيل من منشئاته بل ومن مفاخرها .

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(١) تاريخ مصر لابن إياس جزء ٢ ص ٢٦٤

CENTRES OF ISLAMIC SWORD MAKING IN MIDDLE AGES (1)

by

A. RAHMAN ZAKY

1. ARABS AND IRON INDUSTRY

Information referring to Arab metallurgy and iron working is very scanty. Processes practised by early Moslem craftsmen were traditional and remained secret, but it is certain that the Moslems developped Hindu or Persian methods for forging good steel, and soon they were able to produce steel blades of astounding excellency (2).

Al-Kindi, the Arab philosopher (9th century) mentioned iron in relation to the manufacture of swords, and referred to two different species of iron :

1. Shabarqan or male-iron which is hard and has a darkish colour.

2. Narmahan or female-iron which is soft.

Of these two species, a third is composed, which is named "the compound." Al-Kindi, also mentions steel, which he describes as an alloy, and is not derived directly from the mines. He calls it "the purified" (3).

Ibn Sina (980-1037), in his fifth book, De Anima, according to Roger Bacon, distinguishes three different species of iron :

1st : Iron which is good for striking or bearing heavy strokes, and for being forged by hammer and fire, but not for cutting tools. Of this hammers and anvils are made, and this is what we commonly call iron simply.

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(1) Communication présentée en séance du 5 mars 1956.

(2) Sarton, G. : Introduction to the history of science. Vol. III. Part II. p. 1174 - 1175.

(3) A. Rahman Zaky : Islamic swords in middle - ages. B.I.E. Tome XXXVI. p. 365 - 379. (1953 - 54).

2nd : That which is purer, has more heat in it and is better adapted to take an edge and to form cutting tools, but is not so malleable, viz. steel.

3rd : That which is called "andena." Its special character is that like silver, it is malleable and ductile under a very low degree of heat. In other properties it is intermediate between iron and steel [4].

Ibn el Beitar (died 1248), an Andalusian herbist who wrote an authentic work on botany referred to different species of iron, but he added nothing to previous contribution [5].

When Al Kalkashandi, the Egyptian encyclopedist referred to the Arabic sword, he mentioned that it was made of iron (saif anith) or steel (saif fuladh), or else, adopting a Frankish fashion, of iron with a steel edge (saif mudakkar) [6].

These are the important literary sources of Islamic contribution about iron.

2. IRON MINES

In the lands of the Eastern Caliphate, there were numerous mines of iron and other minerals which were well exploited. These were recorded by Moslem geographers and historians, as well as by European travellers in middle ages.

In Arabia, Bahrein, Oman, and Yemen, there was a very old iron industry working with local iron deposits or steel imported from India, Persia and also China. At Neqem in the neighbourhood of Sana'a in Yemen, there existed gold and iron mines. During the reign of Himiar, in Yemen, excellent yemenite swords were made. The manufacture of weapons also flourished: swords, lances and cuirasses were highly prized [7] and these were much quoted in early Arab poetry.

Persia.

The country of the largest iron output was certainly

(4) Fr. R. Baconis Opera Inedita, 1859, pp. 382 - 383.

(5) انظر أيضا . ابن سينا : القانون فى الطب . جـ ١ ص ١٧٩
ابن البيطار : الجامع لمفردات الأدوية والأغذية . جـ ٢ ص ١٣ . القاهرة

(6) Kalkashandi : Sobh el-Aisha. Vol. 2., p. 132.

(7) Encyc. of Islam. p. 1156.

Persia [8]. There were mines and smelting sites near Tabriz. The Elburz mountains have old mines near Rasht, and Massula where the inhabitants are still mainly blacksmiths. West of Tehran and near Kazwin, there is much haematite, to the east near Firuz Kuh and on the foothills of mount Demawend there is haematite and linonite.

According to Ibn Hawkal, there were in Fars iron and quicksilver in the hills of Istakhr [9]. In the neighbourhood of Shahiq in Fars, according to Mustawfi, were iron mines, and the "Fars Namah" speaks of the excellent swords made there [10]. To the south-east Shahiq, on the borders of Darabjird district, is the town of Kutruh, still a place of some importance, where, according to the "Fars Namah" there were excellent iron mines.

Near both Marashmandah and Minak, there were iron mines, and tools made here were exported to all parts of Khurasan, the steel being of excellent quality ; so that even in Baghdad these were much sought after [11].

In Chorassan there were several deposits near Semendeh and Ilak and in Afghanistan near Juwain and Herat [12].

Marco Polo, the Venitian traveller, who visited many Asiatic countries (1270-1295), mentioned that in Kerman, there are also plentiful seams of steel [13] and ondanique [14]. Very fine large steel mirrors are manufactured there [15]. Marco Polo reported that on the borders of the Province of Ghinghintalas towards the north is a mountain with an excellent vein of steel and ondanique [16].

Chevalier Chardin (1643-1713), the French traveller in Persia and India, makes it quite clear that in his time the Persians

(8) Forbes : Metallurgy in Antiquity. pp. 387,444.

(9) Le Strange : The Lands of Eastern Caliphate. p. 316.

(10) Ibid. p. 278.

(11) Ibid. p. 476, quoted from Ya'kubi. II, 395, 425.

(12) Ibid. p. 387.

(13) The Travels of Marco Polo. Broadway Travellers edition. Edited by Sir E. D. Ross and E. Power. p. 39.

(14) Marco Polo used « Andanicum, Andaine, and Ondanique » as a name applied for Indian watered steel.

(15) Ibid. p. 48.

(16) Ibid. p. 73.

called both theirs and the Indian steel "poulad jauherder," which was, as he further explains:

"Acier ondé, acier qui a des ondes, qui est ce que nous disons acier de Damas pour le distinguer d'avec l'acier de l'Europe" ([17]). Further, Chardin adds: "C'est de cet acier-là qu'ils ont fait leurs belles lames damasquinées."

The expression "ondanique" appears in a quotation from Idrisi the Moslem geographer (C.A.D. 1099-1154) as "hindiah" and found its way into Spanish in the shapes of "Alhinde," "Alfinde," "Alinde," first with the meaning of steel, then assuming, that of steel mirror, and finally that of metallic foil of a glass of mirror ([18]).

In Transcaucasia a few ornaments of iron appear in the thirteenth century in the Ganda Karabeg region. In Georgia and Armenia iron appears in the same period ([19]).

Other Moslem geographers, Yaqut (1228 A.D.) ([20]) and Al-Mukaddisi referred to the iron wealth of Sicily; the ore was exported to India for making delicate instruments during the eight and ninth centuries.

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This is on iron deposits in the lands of the Eastern Caliphate, but what about the useful metal in the western land of the Caliphate: Spain?

Spain had since the time of the Phoenicians had been known as a rich store-house of mineral wealth and was, before the discovery of the deposits outside Europe, a leading world producer of copper, mercury, lead and iron ore ([21]). Its mines contained in perfection all metals applied to warlike uses of that remote epoch.

(17) Voyage du Chevalier Chardin en Perse. p. 355, Paris 1811.

(18) Hint or Al-Hind is used in Berber also for steel. J.R.A.S., vol. IX, p. 255.

(19) Ibid. p. 449.

(20) Yaqut is the compiler of a big geographical dictionary, which contains all geographical names in Alphabetical order. Yaqut: Encyc. vol. I, p. 201. See also Mukaddisi, p. 239 - 240.

(21) Encyclopaedia Britannica: Edit. 1955, p. 145.

The Visigoths established a powerful empire in Spain in the 5th Century under which the arts of ancient civilization were encouraged, including the iron industry.

At about the beginning of the 8th century when the Moslems became masters of much of Spain, they stimulated greatly the manufacture of iron. The natives who had withstood the Moors also, extended their Catalan forges north into France and even to other European countries ([22]). So prominent did the industry of Spain become, that its iron workers were sought by other countries.

India and China.

Beside the iron mines in Islamic territories, the Moslems used to import from India and China enough quantities of good iron. We are not supposed to trace the historical chronology of iron industry in India, but it is enough to say that the Roman trade in Indian iron and steel was an important one ([23]). The great centuries A.D. when the blacksmith must have been skilful, and commanded an unlimited supply of the best metal ([24]).

India was an important iron source to Moslem countries without any contest in middle ages. The sword-blades of medieval India had a great reputation according to many authorities. El-Beiruni in the 10th century referred to the good quality of Indian iron-industry. Indian swords-finished or semi-finished continued to be imported into Persia till days quite recent. Edrisi says on this subject: "The Hindus excel in the manufacture of irons, and in the preparation of those ingredients with which it is fused to obtain that kind of soft iron which is usually styled Indian steel."

China.

North-west of China was, and is still, generally rich in iron-

(22) Goodale: Chronology of iron and steel. p. 28.

(23) Steel made in India was apparently of good enough quality for manufacture into 100 different surgical instruments, according to medical writings that have come down to us from 400 to 300 B.C.

(24) The Lat or iron-pillar of Delhi, India, erected about 415 A.D. shows high skill of iron workers at that time. It is a solid shaft of wraught iron, calculated to weight seventeen tons and to contain eighty cubic feet of metal.

ore ([25]). That mineral was one of the earliest commodities exported from China to the West, and one of the earliest references to its exportation from China to the Roman Orient is given by Pliny (died 79 A.D.) who mentions that Chinese iron was the best known in the Roman markets and that second to it came from Partia ([26]).

The high reputation which the Chinese iron gained in the Roman markets apparently continued during the Arab period. Ibn-Khurdathabba in the 9th century speaks of the exportation of the fine iron of China from the port of Luqueen or Luqin ancient Cattigara, Gulf of Tong-King. Three centuries later, Idrisi, the Moslem geographer, mentions iron amongst the exports of China ([27]). There is therefore some reason to think that the iron workshops of Damascus and other cities renowned in medieval times, had made use of the importation of the fine Chinese iron, which added both to the quantity and quality of the local product of the mines in the Near East.

3. CENTRES OF SWORD-MAKING

a) Islamic East

1) Arabia.

In Arabia, before Islam, Mu'tah in the land of ancient Moab, was famous for its swords. These were known as "al-suiof al mashrafieh." At the same period, the Arabs used to import swords from Ubullah, a little Iraqi town on the Digla river. The blades of Bosra in Syria were often praised by Arab poets, as well as the swords of the town of Aryah.

In Yemen, the sword industry flourished since antiquity.

(25) O. Jance : Quelques Antiquités chinoises d'un caractère hallstattien, in the museum of far Eastern Antiquities, Stockholm, Bulletin, No. 1930, pp. 177 - 83.

(26) Ex omnibus autem generibus palma Serico ferro est, Pliny, Historia Naturalis, XXX, 14 (41), 145, quoted in F. Hirth, China and the Roman Orient, loc. cit., p. 225 - 226, footnote 2.

(27) P.A. Jaubert : Géographie d'Drisi. Paros 1836 - 40, t. 1, p. 51.

This was not only because Yemen once possessed the suitable ore for industry, but also because the Yemenite imported enough quantities of Indian steel. The reputation of Yemenite swords eclipsed after the collapse of the Himiarite dynasty, just before the dawn of Islam. After Moslem conquests, the Arabs soon put their hands on centres of the swords industry in Persia, Syria and other places ([28]).

2) Iran.

Since antiquity, Persia had a reputation for swords-making. In the twelfth century, Ibn al-Balkhi notes that at Chahiq in Fars, excellent swords and other blades called Chahiqi are made ([29]).

Al-Firdawsi, the great Persian poet praised in his "Shah-Nameh" the excellence of Chahiqi blades.

Kirman.

Marco Polo on his visit to Persia, reports that in Kirman, the arm-smith makes all kinds of harness for horsemen, namely bridles, saddles, swords, spurs, bows and arrows, quivers and other weapons after the fashion of those parts ([30]).

Paulus Jovius referred to the reputation of Kirman in the industry of arms during the sixteenth century; Turks used to buy these Kirman swords at high prices ([31]).

Qumm.

Olearius in his voyage during the seventeenth century notes that the best swords he found at Qumm, and are considered the best in the whole country of Persia. The steel of which they are made comes from the city of Miris, four days march from Ispahan ([32]).

(28) S.A. Huzayyin : Arabia and the Far-East. Cairo 1942., p. 200.

(29) Le Strange : Description of the Province of Fars in Persia. London. Asiatic Society Monographs., No. XIV, 1912, p. 24.

(30) The travels of Marco Polo. p. 39.

(31) Jule's Marco Polo. Book XIV. vol. 1. p. 89.

(32) Olearius : Voyage.. fait en Moscovie, Tartarie et Perse. Vol. II, page 681. Leiden 1719.

Khurasan.

In the eighteenth century, the Comte de Ferrières Sanvebœuf speaks of the finest blades being made in Khurasan, and evidently the industry of weapons was very old there; for in the tenth century, we hear of good knives being made in Neisabur. The comte also praises the sabre blades of Qazwin as being much better tempered even than those of Damascus (33).

Isphan.

Isphan in Khurasan province, the old capital of Persia, cannot be ignored as a chief centre of sword-making, notably from the 16th to the 19th century. The swords of "Assad-u-llah" were most probably made at Ispahan. Khwarasm also made good swords and likewise cuirasses and bows. Shiraz is also mentioned by some European travellers as a famous centre of sword-making.

Anyhow, the reputation of Persian swords had been well established. Chardin (1643-1713) gives a very appreciative account of Persian swords. "Their scimitars are very well damasked and exceed all that the Europeans can do, because I suppose our steel is not as full of veins as the Indian steel which they use commonly. They forge their blades cold, and therefore they dip them, they rub them with tallow, oil or butter to hinder them from breaking; then they temper, them with vinegar and coperas, which being of corroding nature, shows those streaks or veins, which they call Damask work" (34).

3) Egypt and Syria.

According to medieval historians, the Fatimides possessed magnificent collections of fascinating arms in their palace-stores, but it is difficult to be precise as to their provenance; whether these weapons were made in Egypt or were imported from Persia, India or Syria. We must not forget the fact that Syria,

(33) Comte de Ferrières - Sainvebœuf : Mémoires historiques, politiques et géographiques., 1782 - 89., Vol. II, p. 9., Paris.

(34) Sir John Chardin's Travels in Persia. The Argonaut Press, London 1927, p. 270 - 71.

namely Damascus was to Cairo an important centre of export. The Syrian capital was a flourishing market for Persian and Indian arms, besides her own. Damascus, from the earliest times has been the market of the surrounding deserts. For centuries, the "Damascus blade" carried far afield the reputation of the city's armourers. Diocletian promoted the industry, but it perished when Tamerlane carried off the smiths in 1401, and became despoiled of all the efficient craftsmen and armourers.

As an important sword-making centre, Damascus has been somewhat exaggerated, especially after Timurlane's destruction. Most probably, the city was not the home of the so-called Damascus-steel, but a processing station from which it was distributed. The metal of the famous Damascus weapons was made at Kona Samundrum of the Hyderabad district of India, as early as the fifth or fourth century B.C. (35), by a fusion process known as wootz (36).

When the Arabs conquered India, they carried the steel wootz cakes to Damascus, where a lively industry in converting this unique material into weapons and armour flourished. Unlike the Romans, the Arabs visited the Indian smeltries and saw how wootz steel was made. They carried this knowledge as far west as Toledo, whence it eventually spread northwards.

Although one meets plenty of Islamic swords so-called Damascus blades, yet most of these belong to the 18th or 19th century industry — these are not at all genuine and are not attributed to middle-ages manufacture.

4) Turkey.

The home of the Turks extends from Central Asia to Eastern Europe including Anatolia, Armenia, and the Caucas. Long before they became Moslems, the Turks had a reputation of being skilful weaponsmiths who worked the iron ores of the Altai for the Avars until their fall (552) (37). Attaining power

(35) Goodale, S. : Chronology of iron and steel, p. 24.

(36) The word wootz belongs to the telengana language of the south-eastern parts of Hyderabad State. It was produced by the carburisation of wrought iron in crucibles.

(37) Forbes : Metallurgy in Antiquity. p. 444.

during the reign of the Abbasides in Bagdad, they got in touch with Persian armourers; and later with the conquest of Syria and Egypt (1517), the Turks transported to their new capital a horde of craftsmen, artists and armourers who helped to develop their arts. Nevertheless, the Ottomans owned their characteristic types of sabres: the qilij and the yatagan. In Anatolia, the Turks inherited the old Byzantine iron deposits in Eastern Asia-minor and in the Taurus mountains. There existed a rich wealth of iron deposits, namely in Alaia, Adana, Amaxia in Upper Cilicia and Galatia [38].

b) Islamic West

Toledo.

Under the Moors, the manufacture of swords throve until the 15th century. Toledo and the sword are indissolubly associated in the literature of arms; it is impossible to mention the name of the city without recalling the unchallenged excellence of the blades it has given to the world. Toledo blades were proverbial for their excellent tempering, and were famous as early as the days of the Romans [39].

Tarik ibn Zeyad, when he took Toledo in 712 A.D., found amongst a profusion of crowns, jewellery, gilded armour, daggers and swords richly mounted, bows, lances and various arms, offensive and defensive.

The sword industry of Toledo had passed under the control of the Arabs; and Abdel Rahman II (822-852) regulated and reformed it. One of the numerous friendly passages between Arabs and Spaniards was marked by a gift of Toledan blades from Al-Kakkam II to Sancho, Count of Navarre (865 A.D.) [40].

Seville.

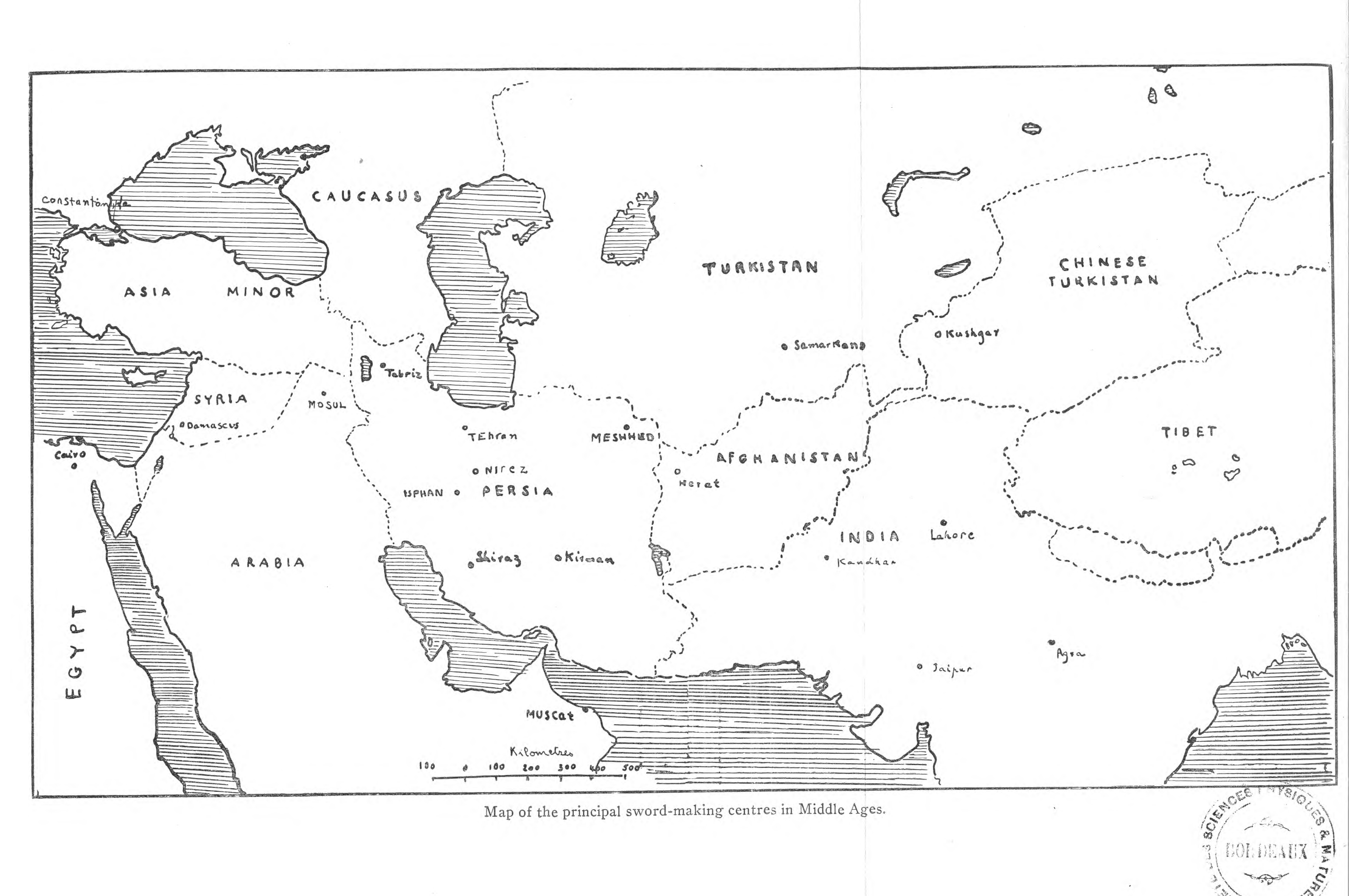
Seville was also noted for the excellence of its steel blades;

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(38) Ibid. p. 386.

(39) Toledan blades have been famous for 2000 years, the « culter toletanus » being mentioned in the « Cynegetica of Gratius » (Faliscus) during the first century B.C. Encyc. Brit., p. 271.

(40) Calvert : Spanish arms and armour. p. 11 - 12.



Map of the principal sword-making centres in Middle Ages.

also Almeria, Murcia and Granada. Al-Makkari, the Andalusian historian, mentions that during the 12th and 13th centuries, Almeria was famous for the fabrication of metal vases and arms. Ibn Saïd the well-known traveller, writing during the 13th century reports that Murcia was also noted by its excellent industry of arms. The traveller said that Seville blades were the most renowned and that its watered steel was its unique characteristic.

In spite of Cordoba, being the important capital of Moslem Spain, yet it was never a centre of arms industry.

Granada.

Among the highly interesting examples of swords, during the 15th century, some of those tempered at Granada still exist in the collections of Spanish museums. The famous sword so-named Boabdil sword, which went to king Ferdinand, the conqueror of Granada (1492) has been kept in Spain since then.



In Moslem Spain, the form of the sword did not develop. It maintained its original Arab type — a straight double-edged blade with a down curving guard, and not like the shape in the Moslem East where it devellopped into various forms.

A map showing the principal sword-making centres in Middle Ages is attached.

A NEW SIMPLE METHOD FOR THE GRAVIMETRIC DETERMINATION OF MERCURY

by

T. M. SALEM

The methods known for the gravimetric determination of mercury are limited and somewhat tedious (1). In the present paper a new simple gravimetric experimental procedure is given by which mercury in both the mercurous and mercuric forms can be easily determined gravimetrically with an accuracy not less than 0.2%. In this method the precipitating agent used is 15% sodium succinate solution.

The idea of this procedure originated from a previous study carried out by the present author (2) on the mercury-mercuric oxide electrode where it was found that when using buffer solution of pH values varying between 3 to 5.8, and containing succinic acid, a white precipitate was always formed over the red mercuric oxide. This precipitate was found to be a well crystalline compound whose analysis showed that it is pure mercuric succinate. Allmand 3) from a study of the potential difference of the mercury-mercuric oxide electrode in sodium hydroxide and potassium hydroxide solutions at 18°C calculated the solubility product of mercuric oxide to be 4×10^{-28}. Garrett and Hirschler (4) from their studies on the solubility and amphoteric character of mercuric oxide showed that the solubility of this oxide is 22.5×10^{-5} gram mol Hg/1000 grams water at 25°C, while El Wakkad and Salem (5) found that the solubility of the orange HgO in water is 3.47×10^{-4} gram mol Hg/1000 ml. at 30°C.

From the above results and the observation noticed on the mercury-mercuric oxide electrode, when using succinate buffer solution one must expect that mercuric succinate possessed lower solubility that the oxide at the corresponding pH values and hence its use for the gravimetric determination of mercury. The method was found to be completely satisfactory for the determination of both mercurous and mercuric mercury in solutions of different concentrations.

EXPERIMENTAL AND RESULTS

Preparation of the Standard Mercurous and Mercuric Solutions:

The standard mercuric stock solution was prepared by dissolving accurately weighed amount of the twice distilled mercury in twice distilled nitric acid and diluting to one litre in a volumetric flask. From this standard stock solution other concentrations were obtained by accurate volumetric dilution.

The standard mercurous stock solution was prepared from the purest B.D.H. mercurous nitrate of grade analar. This solution was standardised with a standard solution of sodium chloride using 1% solution of bromo-phenol blue as an indicator (6). Other concentrations were obtained also by accurate volumetric dilution.

Sodium Succinate:

The sodium succinate used in the gravimetric method was the purest B.D.H. sample from which 15% solutions was prepared.

Conditions of Precipitation of Mercurous and Mercuric Succinate:

After preliminary studies the best conditions for the quantitative precipitation of both the mercurous and the mercuric succinate were found to be as follows:

(I) The pH value of the medium from which the precipitate of the mercury (in both the mercurous and the mercuric forms) is carried out should not be less than about 1.5 and not more than pH 6. Thus when acidified mercurous or mercuric solution containing succinic acid was titrated with sodium hydroxide solution and the variations in both hydrogen ion and mercury ion activities were followed with a glass electrode and an amalgamated platinum electrode respectively, it was found that the mercurous or mercuric succinate started to precipitate only at about pH 1.5 and at which stage a great decrease in the mercury ion activities was noticed. When the pH value exceeded 6 the oxide of mercury started to precipitate. The optimum procedure was to add dropwise about 15% sodium succinate solution to the mercury solution which was slightly acid to methyl orange. The addition being continued until the colour of methyl orange changes to yellow. For the determination of mercurous mercury the solution must be free from silver but lead does not interfere. In the determination of mercuric mercury the solution must be free from chloride ions and ions of the second analytical group. The precipitate formed is left to settle and then filtered through a weighed G 3 Jena sintered glass crucible and washed several times with warm conductivity water.

(II) Drying Temperature : When the precipitate of mercury succinate was dried in an electric oven, it was found that the optimum temperature range for its drying was between 110°C - 120°C. When the dried sample was heated above 160°C to 200°C continuous loss in weight was noticed probably by sublimation. Above 200°C charring of the succinate was found to take place. In all our experiments the precipitates were dried at 120°C to constant weight.

The Succinate Precipitate:

Mercurous succinate $Hg_2C_4H_4O_4$ is a white crystalline solid insoluble in cold and hot water, containing 77.52% (theoretical 77.56%) of mercury.

Mercuric succinate $HgC_4H_4O_4$ is also a white crystalline solid insoluble in cold and hot water containing 63.29% (theoretical 63.35% of mercury).

In table I and II are given some results obtained with the procedure explained before for the gravimetric determination of mercury in both the mercurous and mercuric forms:

Table I

Amount of mercurous mercury present in solution	Weight of precipitated succinate	Amount of mercury found	Error %
g	g	g	
9.8400	12.6880	9.8408	+0.00
4.9200	6.3330	4.9118	—0.16
2.4600	3.1680	2.4571	—0.11
1.9680	2.5436	1.9728	+0.24
1.2300	1.5848	1.2291	—0.07
0.6150	0.7929	0.6149	—0.01

Table II

Amount of mercuric mercury present in solution	Weight of precipitated succinate	Amount of mercury found	Error %
g	g	g	
3.9200	6.1944	3.9241	+0.10
1.9600	3.0972	1.9620	+0.10
0.9800	1.5472	0.9801	+0.01
0.4900	0.7743	0.4905	+0.10
0.3920	0.6186	0.3918	−0.05
0.2450	0.3874	0.2454	+0.16

In the case of a mixture of mercury salts in both states of oxidation advantage was taken for the oxidation of the mercurous state to the mercuric state by heating with nitric acid. To ensure complete oxidation the heating was continued gently to dryness and the residue was digested with nitric acid and heated again. The total mercuric mercury was then determined by precipitation as mercuric succinate in the usual manner. On another sample of the mixture the mercuric mercury present in the mixture was reduced to the mercurous state by shaking with metallic mercury where the reaction :

$$Hg^{++} + Hg = Hg_2^{++} \qquad (1)$$

took place. The reduction was found to take place very quickly. The total mercurous mercury present in the solution was then determined by precipitation as mercurous succinate.

The difference between the quantity of mercury as determined from the mercurous succinate and the mercuric succinate precipitates would give the mercuric mercury originally present in the mixture. Substituting this amount from the total mercury determined from the mercuric succinate would give the mercurous mercury present in the mixture.

The following example shows in details the method of calculating the amounts of mercurous and mercuric mercury present in a solution containing 5.3833 grams of mercurous mercury and 0.4917 grams of mercuric mercury. Thus such a mixture was heated with nitric acid gently till dryness and the residue was digested with nitric acid several times all the mercury would be in the mercuric form, dissolving and precipitating as succinate in the usual manner and weighing the precipitate we obtained 9.7563 grams of mercuric succinate containing 6.1806 grams of mercury. Another identical sample of the mixture was shaken with mercury and thus the mercuric mercury was reduced to the mercurous state according to equation (1) and the solution would be all of mercurous mercury, precipitating as succinate in the usual manner 8.6002 grams of mercurous succinate were obtained which contains 6.6703 grams mercury. The difference between the quantity of mercury as obtained from the mercurous succinate and the mercuric succinate precipitates which is equal to 0.4897 grams would give the mercury which entered during the process of shaking for the reduction of the mercuric mercury in the mixture according to equation (1). This at the same time is equal to the mercuric mercury originally present in the mixture. The mercurous mercury originally present in the mixture would be equal to the difference between the total amount of mercury obtained from the mercuric succinate precipitate and the mercuric-mercury obtained as shown before viz.

6.1806 — 0.4897 = 5.6909 grams of mercurous mercury.

In table III are given some results obtained with the above procedure for the gravimetric determination of mercury in case of a mixture of salts in both states of oxidation.

Table III

Amount of Hg_2^{++}/Hg present in mixture	Amount of Hg^{++}/Hg present in mixture	Weight of pptated $Hg_2C_4H_4O_4$	Weight of pptated $HgC_4H_4O_4$	Amount of Hg_2^{++}/Hg found	Error %	Amount of Hg^{++}/Hg found	Error %
g	g	g	g	g		g	
5.6833	0.4917	8.6002	9.7563	3.6909	+0.13	0.4897	—0.40
2.8416	0.2458	4.2983	4.8447	2.8447	+0.10	0.2445	—0.52
0.5683	0.0491	0.8602	0.9759	0.5692	+0.15	0.0490	—0.20
0.3788	0.0983	0.7386	0.7517	0.3796	+0.21	0.0966	—0.17

From the above results it is clear that the new procedure given for the gravimetric determination of mercury is completely satisfactory for the determination of mercurous and mercuric ions whether they are present each alone or in mixture.

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LE SYSTEME PONDERAL ISLAMIQUE DIT « KEBIR » [1]

par

MARCEL JUNGFLEISCH

En 1926, feu l'antiquaire Raphaël Blanchard nous avait fait cadeau d'un poids en verre qui par sa forme et sa légende sortait de l'ordinaire mais dont une cassure malencontreuse semblait diminuer l'intérêt au point de vue métrologique. Il l'avait acquis de colporteurs d'el Lahoun (province du Fayoum, Moyenne-Egypte) mais sans pouvoir en obtenir aucune précision sur l'origine réelle de l'objet.

Ce poids présente grossièrement la forme d'un bouchon cylindrique, étranglé au milieu et renflé à ses deux extrémités. Celle du haut a environ 30 millimètres de diamètre et porte une inscription à sa face supérieure ; plus large, celle du bas atteint environ 33 millimètres de diamètre mais est entamée par l'enlèvement d'un fort éclat, accident qui d'après l'aspect net et brillant de la cassure, serait récent (coup de pioche lors de la trouvaille ?). Le diamètre est réduit à 27 millimètres environ sur l'étranglement médian du bouchon. La hauteur totale n'est pas uniforme, elle varie entre 25 et 28 millimètres suivant les endroits, les deux extrémités n'étant pas parallèles entre elles.

Le verre est d'une belle couleur vert émeraude, il est translucide et contient de nombreuses petites bulles. Il st légèrement patiné et terni en surface ; la cassure est lisse, à bords coupants.

L'empreinte ne comporte aucun autre entourage que le cordon produit par la pression du cachet sur le verre chaud. La légende est répartie sur quatre lignes horizontales régulièrement espacées.

Okiyeh	وقيـة	وقيـة
exacte par	واو على	واو على
moi Saleh	يدى صلح	يدى صلح
ben Moslem[eh]	بن مسلمة	بن مسلمة

(1) Communication présentée en séance du 6 février 1956.

Il existe un défaut du verre juste sur les dernières lettres de مسلمة et la lecture reste incertaine entre مسلمة et مسلم.

Nous ne savons rien de précis au sujet de ce Saleh ben Moslemeh, cas fréquent pour de nombreux autres intendants des finances abbassides du IIe / IIIe siècle de l'hégire à propos desquels nous dépendons presque uniquement des découvertes fortuites faites par les arabisants dans les papyrus.

Le poids actuel est de 37, 16 grammes après multilation, c'est-à-dire qu'il est notablement trop fort pour une *okiyeh ordinaire*. Il s'agit présentement d'une *okiyeh plus lourde que l'okiyeh commune* ce qui augmente beaucoup l'intérêt qu'il y aurait à *déterminer le poids tout au moins approximatif qu'elle pesait lorsqu'elle était intacte*. Or ceci fut relativement facile avec un peu de soin et de patience.

Il nous a d'abord fallu connaître la densité de ce verre. Après l'avoir bien brossé, nous l'avons frotté avec un chiffon gras pour qu'il ne mouille pas et nous l'avons mis dans un vase, gradué que nous avons rempli d'eau à 15°C. jusqu'au repère. Nous avons retiré l'objet de l'eau avec un fil fin graissé puis au moyen d'une burette de Mohr nous avons rempli d'eau à 15°C. jusqu'au même repère ce qui a nécessité 15,7 centimètres cubes d'eau (chiffre moyen établi par plusieurs essais répétés). Le volume actuel du poids v = 15,7, son poids p = 37,16, nous obtenons $\frac{p}{v} = \frac{37,16}{15,7}$ = 2,37 pour sa densité spécifique. Bien qu'obtenue sans balance hydrostatique (laquelle aurait été plus précise) cette valeur est cependant très proche de la réalité, elle est fort admissible vu la consistance de ce verre et sa nature bulleuse.

Nous avons ensuite confectionné une pâte en pétrissant une partie de plastiline à modeler avec deux parties de cire d'abeille tiède et nous l'avons employée pour remplacer l'éclat manquant en complétant l'objet avec assez d'exactitude grâce aux courbes régulières de sa forme générale. Ce mastiquage mis sous un filet d'eau glacée est devenu assez solide, pour être détaché et manié sans se briser. Son volume v' a été déterminé par la même méthode du vase gradué et de la burette de Mohr, il est de 4,5 centimètres cubes. En supposant que le verre de tout le poids avait une densité uniforme, l'éclat perdu pesait donc v' × d = 4,5 × 2,37 = 10,66 grammes. Le poids intact devait peser 37,16 gr. × 10,66 gr. = 47,82 grammes. Bien entendu, cette reconstitution ne saurait nous donner un chiffre exact au centigramme, ni même au décigramme près mais il y a toutefois lieu de supposer que l'erreur possible est inférieure à un demi gramme et que ce poids au sortir de l'ajustage était fort voisin de 47½ grammes, chiffre dont nous ferons état dans les considérations qui vont suivre.

D'après le tableau de Sauvaire (matériaux pour l'étude de la numismatique et de la métrologie musulmanes. Journal asiatique, 8e série, tome IV, 1884, p. 303), ce poids aurait été plus lourd que les okigehs de Melilah (Maghreb) et d'Alayah (Asie Mineure) pesant 46,347 grammes et plus léger que l'okigeh Layty (51,496 2/3 gr.). Malgré le peu d'écart entre ces grandeurs et malgré la réserve qu'elles ne correspondent qu'à des valeurs théoriques, il nous semble difficile d'attribuer à ces systèmes, l'un maghrébin, l'autre asiatique et peut-être assez tardifs, un poids que tout nous porte à croire égyptien et datable entre 150 et 250 de l'hégire.

Cette okigeh forte relèverait plutôt d'un autre système pondéral particulier à l'Egypte et qui y coexistait avec le système courant. Toutefois, il en différait d'une façon assez manifeste pour qu'à l'usage les poids des deux séries ne puissent être confondus même s'ils n'étaient pas distingués par des désignations spéciales, tout comme nous le constatons encore de nos jours pour les unités « avoir du poids » en Angleterre.

Or, il se trouve que ce système pondéral avait un nom dont il nous a été conservé la trace. Il s'appelait le système « Kébir » d'après des fragments de ratls et d'okiyehs qui portent les désignations explicites وقية كبير . رطل كبير ,et dont quelques uns — malheureusement incomplets — existent dans les principales collections. (Relevé en annexe). C'est à en retrouver les différentes valeurs plus ou moins intactes que doivent désormais tendre nos efforts vers l'élucidation d'un chapitre important de la métrologie islamique. Il est dès maintenant possible d'en conjecturer l'origine. Suivant Decourdemanche (Etude métrologique et numismatique sur les metgals et les dirhems arabes), la réforme d'Abdel Malek ben Merouane avait aboli l'ancien dirhem de la régularisation d'Omar (3,96 2/3 gr.) *en tant qu'unité monétaire seulement*. Cette abolition limitée à la constitution de la nouvelle monnaie n'aurait pas suffi à supprimer tout à fait

l'ancienne drachme qui, par routine, *aurait continué d'exister comme poids commercial*. Or 3,96 2/3 × 12 = 47 gr. 60 okigeh commerciale qui serait précisément du même ordre de grandeur que les 47 ½ gr. de la présente reconstitution. Nous devons donc logiquement nous attendre à rencontrer un jour à venir quelque bloc de verre intact pesant à peu près 570 grammes : le ratl Kebir. Il est d'ailleurs possible que ce système, lui aussi, ait comporté deux séries de valeurs, les unes un peu plus lourdes pour acheter, les autres un peu plus légères destinées à vendre, suivant une coutume traditionnelle en Orient.

ANNEXE

Liste des fragments de poids portant *explicitement* la désignation de « Kébir ».

Dates	Sortes	Références	Catalogues
165/167 H.	1 ratl	n° 44 - p. 390	Casanova
?	1 ratl	n°s 58/59 - p. 393	— id —
?	½ ratl	n° 23 - p. 388	— id —
?	½ ratl	n° 60 - p. 293	— id —
anonyme	½ ratl	n° 34T - p. 27	S. Lane Pode
165/167 H.	¼ ratl	n° 22 - p. 388	Casanova
165/167 H.	¼ ratl	n° 288 - p. 19	F. Petrie
175 H.	¼ ratl	n° 210 - p. 19	— id —
Soliman	1 ratl	n° 216 - p. 20	— id —
anonyme	okiyeh	n° 251 - p. 21	— id —
— id —	2 okiyeh	n° 252 - p. 21	— id —
188 H.	2 okiyeh	n° 116 - p. 139	Miles
186/187 H.		non publié	Jungfleisch

COMPARISON TESTS OF EFFECTIVENESS OF BASIC SETS OF POLYNOMIALS (¹)

by

M. MURSI and A.G. TANTAWI

1. Let $p_n(z) = \Sigma_i p_{ni} z^i$

be a set of polynomials such that any polynomial can be expressed in one and only one way as a finite linear combination of the polynomials of the set. Such a set is called a basic set of polynomials. The coefficients p_{ni} form an infinite matrix P and it has been shown that $\{p_n(z)\}$ will be basic if and only if the matrix P has a row-finite reciprocal matrix Π, i.e. if there exists a row-finite matrix Π such that

$$P\Pi = I \quad \text{and} \quad \Pi P = I$$

weher I is the unit matrix.

2. Let $f(z) = \Sigma a_n z^n$ be a function regulra in $|z| < R$. This can be looked upon as an expression of the function f(z) in terms of the polynomials :

$$1, \ z, \ z^2, \ z^3, \ldots, z^n, \ldots$$

But these last polynomials can be expressed in terms of the polynomials of any basic set $\{p_n(z)\}$ in the form

$$z^n = \Sigma_i \Pi_{ni} p_i(z) \qquad (1)$$

If in the expression $f(z) = \Sigma_{an} z^n$ we replace z^n by its value given by (1) and rearrange the terms we get

$$\Sigma \Pi_i f(o) p_i(z) \qquad (2)$$

where

$$\Pi_i f(o) = \Sigma^n a^n \Pi_{ni} \qquad (3)$$

The series (2) is called the basic series of the function f(z) associated with the basic set $\{p_n(z)\}$ Series (2) is only a formal expression of the function in terms of the polynomials $\{p_n(z)\}$ and it is only in very special cases that the series converges and its sum is f(z).

(¹) Communication présentée en séance du 3 mars 1956.

If the function f(z) is regular in a domuin D and if the basic series (2) converges to f(z) uniformly in D we say that the basic series represents f(z) in D.

Definition 1. — If the basic series (2) represents in $(z) < R$. every function regular in $(z) < R$ then we say that the basic series is *effective* in $(z) < R$.

3. Let $p_n(z) = \Sigma p_{ni} z_{ni}$ be any basic set,
and $z^n = \Sigma_n \Pi_{ni} p_i(z)$ be the expression of the polynomials $1, z, z^2, z^n$, in terms of the polynomials of this set. Write

$$F_n^{st}(z) = \sum_{i:s}^{t} \Pi^{ni} p_i(z)$$

$$F_n^{st}(R) = \max_{|z|=R} |f_n^{st}(z)|$$

and

$$F_n(R) = \max_{s,t} F_n^{st}(R)$$

$$K(R) = \overline{\operatorname{Lim}_n} \{F_n(R)\}^{1/n} \qquad (4)$$

It has been shown that if for some R,

$$K(R) = R$$

Then the set will be effective in $(z) < R$.
If the set $\{p_n(z)\}$ is a simple set the degree of p (3) is exactly then we can calculate K(R) in another way by putting

$$M_i = \max_{|z|=R} |P_n(z)|$$

$$W_n(R) = \Sigma_i |\Pi_{ni}| M_i(R)$$

and $$K(R) = \overline{\operatorname{Lim}_{n\to\infty}} \{w_n(R)\}^{1/n} \qquad (5)$$

The order and type of a basic set in the circle $(z) \leq R$ are defined by

$$F(R) = \overline{\operatorname{Lim}} \frac{\operatorname{Log} F_n(R)}{n \operatorname{Log} n} \qquad (6)$$

and

$$\Phi(R) = \frac{e}{F(R)} \left\{ \overline{\operatorname{Lim}_n} \frac{|F_n(R)|^{1/n}}{F(R)} \right\}^{\frac{1}{F(R)}} \qquad (7)$$

$(o < F(R) < \infty)$.

The representation of any function by means of a basic set depends on the magnitude of K(R) as well as the order F(R) and the type Φ (R) of the set and it has been so far customary to calculate these function for any basic set $\{p_n(z)\}$ to show whether this set is effective in a domain or not.

4. In the present paper we shall establish some theorems from which we can know whether a basic set is effective or not by comparing it with a known basic set. The method followed is suggested by the ordinary theory of infinite series. We shall also discuss a class of basic sets which will be used for comparison.

Definition 2. — Let $\{p_n(z)\}$ and $\{\bar{p}_n(z)\}$ be two basic sets and let

$$K(R), \quad F(R), \quad \Phi(R)$$

and $$\bar{K}(R), \quad \bar{F}(R), \quad \bar{\Phi}(R)$$

be the functions defined above for these sets respectively. If for all $R > o$

$$K(R) = \bar{K}(R)$$
$$F(R) = \bar{F}(R)$$
$$\Phi(R) = \bar{\Phi}(R)$$

then the two sets are said to be *equivalent*.

Definition 3. —

$$K(R) = < \bar{K}(R)$$

or $$F(R) = < \bar{F}(R)$$

then the first set $\{p_n(z)\}$ is said to be stronger than the second set $\{\bar{p}_n(z)\}$ and we denote this by

$$p_n(z) \sqsupset p_n(z).$$

We prove the following theorems :

Theorem 1. — If the two sets $\{p_n(z)\}$, $\{\bar{p}_n(z)\}$ are such that

$$p_n(z) \equiv \bar{p}_n(z)$$

for all large n then the two sets are equivalent.

For let $\bar{p}_n(z) = p_n(z)$ for all $n > N$, express $p_0(z), p_1(z), \dots p_{N_1}(z)$ in terms of the polynomials $\bar{p}_0(z), \bar{p}_1(z) \dots, \bar{p}_{N_2}(z)$ and let $N = \text{Max}\,(N_1, N_2)$ We thus have $p_n(z) = \Sigma_i\, \alpha_{ni}\, \bar{p}_i(z)$ $\quad 0 \leq n \leq N$

$$p_n(z) = \bar{p}_n(z) \qquad \text{for all } n > N$$

Hence

$$z^n = \Sigma\, \pi_{ni}\, p_i(z)$$

$$= \sum_0^N \Pi_{ni}\, \Sigma\, \alpha_{ij}\, \bar{p}_j(z) + \sum_{i > N} \Pi_{ni}\, \bar{p}_i(z)$$

$$= \sum_{j:0}^{N} \left(\sum_{i:0}^{N} \pi_{ni}\, \alpha_{ij} \right) \bar{p}_j(z) + \sum_{i > N} \pi_{ni}\, \bar{p}_i(z) \qquad (8)$$

But $\{\bar{p}_n(z)\}$ is basic and hence

$$z^n = \Sigma\, \bar{\pi}_{ni}\, \bar{p}_i(z) \qquad (9)$$

From (8) and (9 we have

$$\bar{\pi} = \Sigma\, \pi\, \alpha \qquad \text{for } i \leq N$$

and

$$\bar{\pi} = \pi \qquad \text{for all } i > N$$

Hence if $n \leq N$

$$\bar{f}^{st}_n(z) = \sum_{i=s}^{t} \bar{\pi}\, \bar{p}(z)$$

$$= \sum_{i=s}^{N} \left(\sum_{j=0}^{N} \pi_{nj}\, \alpha_{ji} \right) \bar{p}_i(z) + \sum_{i=N+1}^{t} \pi_{ni}\, p_i(z)$$

$$= \sum_{j=0}^{N} \pi_{nj} \sum_{i=s}^{N} \alpha_{ji}\, \bar{p}_i(z) - \sum_{i=s}^{N} \Pi_{ni}\, p_i(z) + f^{st}_n(z)$$

On the other hand if $n > N$

$$\bar{f}^{st}_n(z) = f^{st}_n(z)$$

In either case we have on taking modulii

$$\bar{F}^{st}_n(R) \leq K(N) + F^{st}_n(R)$$

and hence

$$\bar{F}_n(R) \leq K_1(N) + F_n(R)$$

giving $\qquad \bar{K}(R) \leq K(R)$

and $\qquad \bar{F}(R) \leq F(R)$

which proves that $\{\bar{p}_n(z)\}$ is stronger than or equivalent to $\{\bar{p}_n(z)\}$ In the same way we prove that $\{\bar{p}_n(z)\}$ is stronger than or equivalent to $\{p_n(z)\}$ Hence the two sets are equivalent.

Definition 4. — If the nth polynomial of the simple set $\{p_n(z)\}$ can be put in the form

$$p_n(z) = -\Sigma\, p_{ni}\, z^i + z^n$$

or in the form

$$p_n(z) = -\Sigma\, p_{ni}\, z^i + z^{ni}$$

wehere $p_{ni} > 0$ for all $i < n$ and all n, we say that $\{p_n(z)\}$ is a set of positive terms.

Theorem 2. — Let $\{\bar{p}_n(z)\}$ be a simple set of positive terms which can be put in the form

$$\bar{p}_n(z) = -\Sigma\, \bar{p}_{ni}\, z^i + z^n \quad , \quad \bar{p}_{ni} > 0$$

and let $\{p_n(z)\}$ be any other simple set which can be put in the form

$$p_n(z) = \sum_{i=0}^{n-1} p_{ni}\, z^i + z^n$$

If $\quad |p_{ni}| \leq |\bar{p}_{ni}|$ for all large n and all $i < n$ then $\{p_n(z)\}$ is stronger than or equivalent to $\{\bar{p}_n(z)\}$

Proof. Let

$$z^n = \sum_i \Pi_{ni}\, p_i(z) = \sum_i \bar{\Pi}_{ni}\, \bar{p}_i(z)$$

Hence

$$\Pi_{00} = \bar{\Pi}_{00} = 1$$

We can prove by induction that

$$|\pi_{ni}| \leq |\bar{\pi}_{ni}| \quad \text{for all } i \leq n \text{ and all } n$$

But $M_n(R) \leq \sum_{i:o}^{n} |p_{ni}| R^i \leq \sum_{i:o}^{n} |\bar{p}_{ni}| R^i \leq \sum_{i:o}^{n} \bar{M}(R)$

by Canchy's inequality

Hence

$$M_n(R) < (n+1)\, \bar{M}_n(R) \quad \text{for all } n.$$

Hence
$$W_n(R) = \Sigma\, |\pi_{ni}|\, M_i(R)$$
$$\leq \Sigma\, \bar{\pi}_{ni}\, (i+1)\, \bar{M}_i\, (R)$$
$$\leq (n+1)\, \Sigma\, \bar{\pi}_{ni}\, \bar{M}_i\, (R)$$
$$= (n+1)\, \bar{w}_n\, (R)$$

Which gives $K(R) \leq \bar{K}(R)$

and $F(R) \leq F(R)$

Corollary. Let

$$p_n(z) = \sum_{i:o}^{n:1} p_{ni} z^i + z^n$$

Where the coefficients p_i are completely arbitrary and if we put

$$\bar{p}_n(z) = -\Sigma\, |p_{ni}|\, z^i + z^n$$

then the set $\{p_n(z)\}$ is stronger than or equivalent to the set $\{p_n(z)\}$ If the set $\{p_n(z)\}$ is effective for some value of R we say that $\{p_n(z)\}$ is *absolutely effective* there.

5. *A Comparison set.* — Finally we give the following set which may be used for comparison :

$$p_o(z) = 1$$
$$p_n(z) = -\sum_{i\text{-}o}^{n\text{-}1} a_n b_i \frac{C_n}{C_i} z^i + z^n \qquad (1)$$

where $C_n > o\ ,\ \alpha_n \geq o\ ,\ b_n \geq o$

For this set we have

$$p_{n+1}(z) = -\Sigma\, \alpha_{n+1}\, b_i \frac{C_{n+1}}{C_i} z^i + z^{n+1}$$

$$= \left[p_n(z) - Z^n \right] \frac{\alpha_{n+1}}{\alpha_n} \frac{c_{n+1}}{c_n} - \alpha_{n+1}\, b_n \frac{c_{n+1}}{c_n} z^n + z^{n+1}$$

Giving $z^{n+1} = \dfrac{\alpha_{n+1} C_{n+1}}{\alpha_n\ c_n} (1+\alpha_n b_n) z^n - \dfrac{\alpha_{n+1} C_{n+1}}{\alpha_n\ c_n} p_n(z) + p_{n+1}(z)$

Hence

$$1 = p_o(z)$$
$$z = \alpha_1 b_o \frac{C_1}{C_o} p_o(z) + p_1(z)$$

and in general

$$z^n = \sum_{i=o}^{n-1} A_{n-1,i}\, \alpha_n b_i \frac{C_n}{C_i} p_i(z) + p_n(z)$$

where $A_{n,n} = 1$

and $A_{ni} = (1+\alpha_n b_{n-1}) \dots (1+\alpha_{i+1} b_{i+1})$

Thus $M_n(R) \leq \sum_{i.o}^{n+1} A_{n-1,i}\, \alpha_n b_i \frac{C_n}{C_i} R^i + R^n \leq (n+1) M_n(R)$

and $w_n(R) \leq \sum_{i:i}^{n-1} A_{n-1,i}\, \alpha_n b_i \frac{C_n}{C_i} \left| \sum_{s:o}^{i-1} \alpha_i b_s \frac{C_i}{C_s} R^s + R^i \right|$

$$+ \sum_{i:o}^{n\ 1} \alpha_n b_i \frac{C_n}{C^i} R^i + R^n \leq (n+1)\, w_n\, R)$$

giving

$$w_n(R) \leq z\, \alpha_n c_n \left[\sum_{s:o}^{n-1} A_{n-1,s} \frac{b_s}{c_s} R^s \right] + R^n$$
$$\leq (n+1)\, w_n(R)$$

Thus can deduce the following theorem.

Theorem 3. — If in the above comparison set of positive etrms we have

$$\overline{Lm}\ \alpha_n^{1/n} = \alpha\ ,\quad \overline{Lm}\ b_n^{1/n} = b$$

$$\overline{Lm}\ \frac{1+\alpha_n b_n}{n^{\nu}} = 1,\quad \overline{Lm}\ \frac{c_n}{n^{\mu}}^{1/n} = k$$

Then the set is of increase

$$\text{order} \leq \mu+\nu \text{ and Type } \frac{1}{\mu+\nu} (\text{la } k e^n)^{\frac{1}{n+\nu}}$$

For them we have

$$A_{ni} \leq (1+t)^{n-i} \left(\frac{n!}{i}\right)^{\nu}$$

and $w_n(R) \leq K n^{\nu} (a+t)^n (k+t)^n (1+t)^n\, n^{\mu n}\, n!^{\nu} + R^n$

giving the result stated.

REFERENCE

Series of Polynomials by J.M. Whittaker (Cairo University Press).

COMPOSITION DE LA COMMISSION DES SCIENCES ET ARTS D'EGYPTE [1]

par

JEAN-EDOUARD GOBY

En 1798 Bonaparte se fit accompagner en Egypte par des civils, distincts de ceux des Administrations dont, avant le départ, l'ensemble fut désigné par l'expression : « savants et artistes attachés à l'Armée d'Angleterre » [2]. Après le débarquement, ces divers personnages furent réunis dans un organisme particulier auquel on donna le nom de « Commission des Sciences et Arts » [3]. Le groupement, dont les membres devaient jouer un rôle capital dans l'histoire scientifique de l'Expédition, a fait l'objet d'études fort nombreuses. Pourtant en dépit des travaux de nos devanciers, certains points restent encore obscurs ou confus en la matière et il est en particulier possible d'apporter des lumières nouvelles sur la composition quantitative et qualitative de l'organisme. C'est ce que nous avons tenté de faire en utilisant en même temps que les travaux imprimés bien connus [4], des sources manuscrites presque toutes ignorées des

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(1) Communication présentée en séance le 5 décembre 1955.

(2) On sait que le but véritable de l'Expédition ne fut dévoilé aux participants que lorsque la flotte française eut quitté Malte.

(3) Nous avons indiqué précédemment que le nom de « Commission des Sciences et Arts » fut proposé par Costaz *(Bull. Inst. Egypte,* t. XXXV, p. 81. Il est fait d'autre part une allusion précise à la création en Egypte de la Commission dans un Ordre du Jour de Kléber en date du 29 fructidor an VII (Cf. *Ordres du Jour* de ce général).

(4) Nous avons renoncé à donner dans les notes qui suivent des indications bibliographiques complètes. On pourra se reporter à la Bibliographie de Munier terminant les *Tables de la Description de l'Egypte* et à une communication antérieure *(Bull. Inst. Egypte,* t. XXXIII, p. 305-322). Nous employerons plus loin les abréviations suivantes :

BIE	Bulletin de l'Institut d'Egypte (moderne).
CE	Courrier de l'Egypte.
CHE	Cahiers d'Histoire égyptienne.
CN	Correspondance de Napoléon (Edition Plon).
EEJ	L'Expédition d'Egypte, de La Jonquière.

spécialistes jusqu'à ce jour [5].

Il convient évidemment de distinguer la Commission des Sciences et Arts d'une part de la Société savante recrutée par cooptation que fut le premier Institut d'Egypte [6], d'autre part de la Commission de publication de la *Description de l'Egypte* formée en France à la suite du décret du 17 pluviôse en X (6 février 1802) [7]. L'organisme dont nous nous occuperons groupa des personnages très divers, les uns illustres, les autres fort obscurs et dont les noms ne sont pas tout à fait oubliés aujourd'hui, uniquement parce qu'ils voisinaient avec ceux des premiers. En dehors de la répartition des membres en dix classes d'émoluments [8], il n'a, à notre connaissance, jamais été pris de décision officielle relative à la Commission et aux personnes qui la composaient. D'autre part la diversité des qualités, des professions, des âges des membres du groupement ne permet pas de leur donner une définition commune. Par suite, on peut dire que sauf erreur matérielle évidente, la définition de la Commission résulte uniquement de l'inscription sur les listes officielles de l'époque, d'un certain nombre de personnages. Il est donc

HBC Histoire et bibliographie critique, de Guémard.
HSM Histoire scientifique et militaire ..., de Reybaud.
JI Journal d'un Ingénieur, de Jollois.
JS Journal et souvenirs, de Villiers du Terrage.
LEE Lettres écrites d'Egypte, de Geoffroy Saint-Hilaire.

(Sauf indication contraire expresse, les chiffres romains indiquent des tomes et les chiffres arabes renvoient à des pages).

(5) A l'exception des *Carnets de Redouté*, ces documents manuscrits sont conservés aux Archives de la Guerre, à Vincennes, aux Archives Nationales et à la Bibliothèque Nationale de France, à Paris.

Nous userons des abréviations suivantes :

AGV Archives du Dépôt de la Guerre, à Vincennes.
ANF Archives Nationales de France, à Paris.
CMR Carnets manuscrits de Redouté (Cf. *BIE*, XXX, 77-91).
NAF Manuscrits du fonds des Nouvelles acquisitions françaises, Département des Manuscrits de la Bibliothèque Nationale, à Paris.

(6) Sur la composition du premier Institut d'Egypte, Cf. *BIE* XXIX, 345-367 et XXX, 81-99.

(7) Sur cette commission et ses travaux, on consultera surtout les manuscrits de la Bibliothèque Nationale (*NAF*, Nos. 3.577 - 3.587, 21.934 - 21.992, 23.815 - 23.818).

(8) *CN*, V, No. 3.480.

essentiel de rechercher ces listes puis d'en faire une étude critique et comparative.

Dès le 6 germinal an VI (26 mars 1798) Bonaparte communiquait au Ministre de l'Intérieur et à celui des Relations extérieures vingt-six noms de savants et d'artistes qu'il désirait emmener avec lui [9]. Un peu plus tard, à une date antérieure au 4 floréal, était dressée une liste, actuellement conservée aux Archives Nationales [10], comprenant 124 noms répartis en seize sections d'importance variable [11]. Sur ces 124 personnes, un assez grand nombre ne quittèrent pas la France. En revanche, de nombreux membres de la future commission ne sont pas inscrits sur la liste des Archives. Enfin la répartition en sections peut être critiquée car certaines renfermaient des éléments fort divers. C'est ainsi que sur les 14 membres de la Section de « Mécanique », l'on trouvait un « savant », Gaspard Monge ; un aérostier Conté ; deux élèves de l'Ecole polytechnique, Favier et Dubois et enfin des « artistes mécaniciens » que l'on nommerait aujourd'hui des « agents de maîtrise ». Ce cas, particulièrement caractéristique, est loin d'être unique. Pourtant, malgré ses imperfections, cette liste fut largement diffusée et utilisée à l'époque de l'Expédition et plus tard par les auteurs qui publièrent des listes nominatives de l'organisme. Il n'est que de confronter la Liste des Archives avec celles données par Laus de Boissy [12], Herbin de Halle [13], Bourrienne [14] et Norry [15]

(9) *CN*, IV, Nos. 2.452 - 2.454 et *EEJ*. I, 245 - 246.

(10) *ANF*, Carton F17A 1.100, Dossier No. 5. La liste est conservée en deux exemplaires.

(11) Les noms et la composition numérique des sections étaient les suivants :

Géométrie	7	Botanique	5	Dessin	3
Astronomie	4	Zoologie	5	Génie Civil	18
Mécanique	14	Chirurgie	6	Géographie	16
Horlogerie	13	Pharmacie	3	Imprimerie	22
Chimie	7	Antiquités	3		
Minéralogie	5	Architecture	3		

(12) *Bonaparte au Caire*, 211 - 212.

(13) *Conquête des Français en Egypte*, 351 - 352.

(14) *Mémoires*, Edit. 1829, t. II, 381 - 382.

(15) *Relation de l'Expédition d'Egypte*, 58 - 59

pour s'en convaincre ([16]). Plus tard Martin ([17]) et Reybaud ([18]), conservèrent les grandes lignes et laissèrent subsister certaines erreurs.

C'est pourquoi il convenait de rechercher d'autres documents ; c'est ainsi que nous avons eu l'idée de nous reporter aux listes de passagers des bâtiments de l'escadre ayant transporté l'Armée d'Orient de France en Egypte ainsi qu'aux états comptables dressés en Egypte même, en vue de payer les membres de la Commission.

On a conservé à Vincennes ([19]) les listes nominatives des passagers de dix vaisseaux, établies avant le départ de Toulon ([20]). Redouté nous a laissé les noms de ses compagnons à bord de *La Diane* ([21]). Ces diverses listes, dans lesquelles les

(16) La première liste - 124 noms - reproduit à deux modifications près concernant Say et Mollard la liste des Archives. La seconde - 119 noms - est la copie de la première, sauf en ce qui concerne certains imprimeurs. La troisième reproduit textuellement la seconde. En revanche, Norry a apporté un certain nombre de corrections judicieuses bien que sa liste de 117 noms renferme encore de nombreuses inexactitudes.

(17) L'Ingénieur P.D. Martin, issu de l'Ecole des Ponts et Chaussées de Toulouse qui prit part à l'Expédition n'appartint pas à la Commission des Sciences et Arts en 1798. Il publia en 1815 une *Histoire de l'Expédition française en Egypte* renfermant une liste de 103 membres dont 3 imprimeurs seulement (I, 144 - 145).

(18) Reybaud a dressé une liste de 115 noms sur lesquels 5 d'imprimeurs (*HSM*, III, 51 - 53).

(19) Carton B⁶ 187.

(20) Ces listes sont les suivantes : *L'Aquilon :* J.M. Le Père, Nouet, Quenot, Méchain, G.Le Père, Chabrol, H.Le Père, Lenoir. — *Le Conquérant :* Girard, Coutelle, Le Noble, Duval, Saint-Genis, Monine, Duchanoy. — *Le Franklin :* Fourier, Norry, Conté, J.B. Lepère, Parseval, Gloutier, Devilliers, Ripault, Panhusen, Cécile, Fouquet, Fuseau. — *Le Généreux :* Testevuide, Jacotin, Simonel, Bertre, Corabœuf, Pottier, Laroche, Dulion, E.F. Jomard, Lecesne. — *Le Guerrier :* J.B. Jomard, Fèvre, Jollois, Lancret, Protain, Demoulain, Protal. — *Le Guillaume Tell :* Costaz, Corancez, Alibert, Caristie, Joly. — *Le Peuple Souverain :* Pourlier. — *Le Spartiate :* J.P. Champy, N. Champy, Charbaud, Favier, Piquet, Viard, Vincent, Le Brun. — *Le Thimoléon :* Bodard, Faye, Thévenod, Arnollet, Moret. — *Le Tonnant :* Dolomieu, Cordier, Descotils, Rozière, Dupuis, Cordier, Coquebert, Gérald, Dubois (Aymé).

(21) Redouté (*CMR*, I, 32) a donné les noms suivants : Passagers : Dabucontrol, chirurgien; Plane, pharmacien; Blanc, inspecteur des Lazarets. — Membres de la Commission : Rigo, Nectoux, Delile, Raffeneau, Redouté.

noms des personnages cités sont suivis de leurs qualités ([22]) sont intéressantes par leur réunion et aussi séparément car elles donnent certains renseignements sur les qualités et les affinités qui pouvaient réunir et unir les groupes de passagers. C'est ainsi que sur *Le Généreux* avaient pris place les trois ingénieurs géographes venus du Cadastre de la Corse et les sept élèves-géographes anciens polytechniciens. L'on trouve les trois astronomes sur *L'Aquilon* et les ingénieurs des Mines sur *Le Tonnant*. C'est pourquoi, nous regrettons vivement de ne pas posséder les listes relatives à tous les bâtiments ([23]).

La Comptabilité de l'Armée d'Egypte, déposée après l'Expédition à la Cour des Comptes, fut brûlée en 1871 pendant la Commune. Mais fort heureusement, Edme-François Jomard avait eu l'idée de demander en 1825 au Greffe de la Cour copie de plusieurs des *Pièces produites par Estève, ancien trésorier de l'Armée d'Orient, à l'appui de son compte pour les exercices des ans VI et VII*. Ce sont des états de sommes dues nominativement pour divers mois aux « membres et employés » de la Commission. Ces documents constituent donc des listes officielles des membres de l'organisme. Le premier état, de 135 noms, est relatif aux mois de floréal et messidor an VI ([24]) et le second, de 151 noms, au mois de prairial de la même année ([25]). Dans le premier état, les membres sont répartis dans les dix classes mentionnées précédemment. Dans le second, les membres rangés par qualités, ceux appartenant à l'Institut d'Egypte figurant en tête, ce qui prouve évidemment que la liste a été établie *a posteriori* ([26]). L'état relatif au mois de messidor an VII ([27]) comporte

(22) Pour ne pas trop alourdir les notes de ce mémoire, nous n'avons pas reproduit les qualités des passagers des vaisseaux.

(23) Nous n'avons pas retrouvé les listes relatives à *L'Alceste*, à *L'Heureux*, à *L'Orient*, au *Causse*, et au *Dubois* non plus que celles concernant les frégates autres que *La Diane*. Nous savons du moins que Berthollet et, à partir de Malte, Monge, se trouvaient sur *L'Orient*, que Geoffroy Saint-Hilaire était passager de *L'Alceste* (*LEE*, 27) tandis que Savigny était sur *Le Dubois* (Ibid., 31).

(24) *NAF*, No. 21.950, Fos. 81 - 85.

(25) *Ibid*, Fos. 88 - 89.

(26) L'Institut d'Egypte fut, on le sait, créé par arrêté du 5 fructidor (22 août 1798), donc bien après le mois de prairial (19 mai - 18 juin).

(27) *NAF*, No. 21.950, Fos. 86 - 87. La présentation de l'état est analogue à celle de l'état de floréal - messidor an VI mais les imprimeurs n'y figurent plus.

81 noms, les intéressés étant répartis en sept classes seulement.

On possède encore à Vincennes un *Etat des Citoyens non militaires qui sont payés par le payeur général de l'Armée d'Egypte* [28], établi à la date du 6 fructidor an VI (23 août 1798) dont le premier paragraphe concerne les membres de la Commission des Sciences et Arts au nombre de 145 répartis en neuf classes. Enfin, au retour de France, il fut dressé un *Tableau général de l'Armée d'Orient aux ordres de Napoléon Bonaparte contenant les noms des généraux et officiers supérieurs dans tous les corps, ceux des Administrateurs et autres personnages faisant partie de l'Expédition, à l'époque du départ de France pour l'Egypte en floréal an VI et au retour de l'Egypte en France, à la fin de l'an 9 et au commencement de l'an 10* [29].

Les listes imprimées de l'*Annuaire de l'An VIII* [30] et de l'*Annuaire de l'an IX* [31] utilisées par Guémard et dans lesquelles la répartition des membres en sections est plus judicieuse que dans la liste des Archives Nationales, sont évidemment des sources précieuses d'information. Il en est de même de la *Liste générale des membres composant la Commission des Sciences et Arts d'Egypte, avec le lieu de leurs domiciles, en date du 1er messidor an VII (19 juillet 1799)*, établie par Redouté et que nous avons publiée antérieurement [32]. Il convient enfin de ne pas négliger la liste de Reybaud non plus qu'une liste manuscrite conservée à la Bibliothèque Nationale dressée en 1823, peut-être par Jomard [33].

(28) *AGV*, Carton B[6] 6, Dossier du 6 fructidor. Ce document est une copie d'une pièce originale de la « Collection Napoléon ».

(29) *AGV*, Carton B[6] 187, Pièce 15.347.

(30) Pages 107 - 109.

(31) Pages 41 - 44.

(32) *CHE*, V, 290 - 301. Cette liste contient toutefois des noms de personnages qui n'ont certainement jamais fait partie de la Commission de sorte que le document intéressant en lui-même, doit pourtant être utilisé avec précaution. Il convient de rappeler également que Redouté a rédigé le Carnet contenant la liste après le retour en France.

(33) Cette liste qui fait partie des Archives de la Commission de la publication de la *Description de l'Egypte* (*NAF*, 21.950. Fo. 78), comportait initialement 105 noms. On a ajouté d'une autre encre le nom de Larrey et in fine, les noms de Legentil, Bouchard, Vincent, Nouet, Lemaître, Pouqueville, Bessières. Au crayon figure la mention «39 morts en 1823», ce qui nous autorise à dater la liste de cette année-là.

Nous disposions donc de sources plus complètes [34] que celles utilisées naguère par Marc de Villiers du Terrage [35] et par Gabriel Guémard [36] : il était donc possible de reprendre leurs travaux. En vue d'obtenir une Liste nominative des membres de la Commission à l'époque de sa création au débarquement en Egypte, nous avons d'abord dressé un *Etat récapitulatif* [37] dans lequel sont portés, par ordre alphabétique [38], les noms des personnages figurant sur une au moins des six listes manuscrites dont les originaux sont à peu près contemporains de l'Expédition en ajoutant ceux des hommes considérés par Redouté ou Reybaud comme ayant appartenu à l'organisme. En face de chaque nom, nous avons indiqué par des lettres conventionnelles s'il figurait sur une ou plusieurs des onze listes énumérées précédemment.

La lecture de l'Etat permet de constater que les listes de floréal, de prairial et de fructidor an VI renferment plusieurs noms qui n'avaient jamais été cités par aucun auteur d'études sur l'Expédition tandis que la liste de messidor an VII, à deux exceptions près [39] et l'*Etat général* de Vincennes ne mentionnent que des noms connus. Quels sont donc ces personnages mystérieux, au nombre de plus d'une dizaine, nous ne saurions évidemment le dire. Il est du reste probable que plusieurs raisons doivent être invoquées pour expliquer leur présence sur les listes. Il est possible que ces hommes de peu de notoriété soient restés très peu de temps attachés à la Commission et

(34) Le manuscrit *NAF*, 21.950 renferme encore des copies d'états partiels d'appointements pour divers mois et des listes nominatives de la Commission pour le mois de fructidor an 8 (Fo. 7427) de 37 noms et le second trimestre de l'an 9 (Fo. 761) de 31 noms. Pour certains groupes particuliers l'on dispose encore d'études partielles précieuses, par exemple des travaux de Tarbé de Saint-Hardouin pour les ingénieurs des Ponts et Chaussées et des papiers de Jacotin, publiés par Pallary, pour les ingénieurs géographes.

(35) *JS*, 335 - 354.

(36) *HBC*, 45 - 65.

(37) Voir Annexe No. 1 à la Communication.

(38) Aucune des listes précédentes n'est établie par ordre alphabétique. Les recherches sont donc laborieuses. *L'état récapitulatif* sert également d'Index à la *Liste nouvelle* faisant l'objet de l'Annexe No. 2.

(39) Il s'agit d'un interprète nommé Lenoble, porté également sur la liste des passagers du *Conquérant* et d'un «artiste mécanicien» nommé Desfours.

aient rapidement été oubliés par suite de leur insignifiance. Ensuite il peut y avoir eu des erreurs de transcription [40]. Enfin des inadvertances de classification ont pu avoir eu lieu. Par exemple, le nom d'un certain Boulouvard figure au nombre des « élèves » sur la liste de prairial et sur la liste de fructidor an VI. Or, dans cette dernière liste, l'on retrouve le même nom de Boulouvard parmi ceux des commis de l'Administration de l'Enregistrement. On comprendra aisément qu'il ait été possible de commettre certaines erreurs dans l'établissement des listes des membres de l'organisme, si l'on veut bien se souvenir que, avant le départ, ceux-ci ne se connaissaient généralement pas entre eux, qu'ils firent le voyage dispersés sur un grand nombre de bâtiments, qu'en Egypte, ils ne furent jamais réunis, qu'enfin, ils étaient d'âges, de conditions et de rangs fort divers.

Quoi qu'il en soit, l'utilisation de l'*Etat récapitulatif* était commode pour dresser la liste nouvelle. Compte tenu de ce que nous savions des décès, des départs, des changements d'affectation sur lesquels nous reviendrons, nous pouvions considérer l'appartenance d'un grand nombre de personnages de l'*Etat récapitulatif* à la Commission comme certaine. De même le fait que d'autres n'étaient portés sur aucune liste manuscrite des ans VI et VII nous a permis de penser que ces hommes n'avaient pas appartenu à la Commission au milieu de 1798. Ce fut par exemple le cas d'officiers comme Say et Malus, de l'interprète Venture, attaché au Quartier Général, de l'ingénieur des Ponts et Chaussées Martin. Certes, d'autres cas étaient beaucoup moins nets. Nous avons hésité pour inscrire ou non certains personnages sur la liste, mais nous croyons inutile de rapporter en détail nos réflexions sur ces points d'importance malgré tout mineure. Sauf exceptions justifiées par des raisons sérieuses, nous n'avons pas considéré comme ayant fait partie de la Commission les hommes qui ne figuraient pas sur les listes manuscrites. D'autre part, nous avons classé parmi les « cas douteux » la plupart des inconnus dont nous venons de parler.

(40) Deux erreurs de transcription certaines se trouvent, par exemple dans la liste des passagers de *L'Oiseau* donné par Jollois (*JI*, 138) : l'éditeur a lu «Costaz» pour Castex, et «Merliam» pour Méchain.

En définitive nous avons obtenu les catégories suivantes :

Membres absolument certains ou très probables	151
Personnes demeurées en France	26
Personnes restées à Malte	2
Cas douteux	15
Personnes venues en Egypte mais n'ayant très vraisemblablement jamais appartenu à la Commission	22
Total	216

Pour chaque membre de la *Liste nouvelle des Membres de la Commission des Sciences et Arts à l'arrivée de l'Armée en Egypte*, nous avons indiqué, chaque fois du moins que nous étions en mesure de le faire [41], les prénoms, les années de naissance et de décès, la classe d'émoluments et avons précisé encore si l'intéressé avait quitté prématurément l'Egypte ou s'il était mort avant de revenir en France.

Les membres ont été répartis en sections par qualités et professions telles qu'elles figurent sur les listes de floréal et de prairial an VI ; nous avons indiqué en italiques les noms des 41 « Elèves » que l'on appellerait aujourd'hui élèves-ingénieurs, étudiants ou lycéens. Cette répartition peut être résumée par le tableau récapitulatif suivant :

Géomètres et chimiste	5
Astronomes et élève	3
Naturalistes et élèves	7
Artistes et architectes	13
Divers (y compris 3 femmes d'imprimeurs)	27
Ingénieurs	28
Artistes mécaniciens et imprimeurs	36
Elèves ingénieurs, polytechniciens et élèves de mathématiques	32
Total	151

(41) Pour trouver ces renseignements, nous avons utilisé les travaux de Guémard, et avons consulté les répertoires énumérés dans une communication antérieure (*BIE*, XXXIII, 312 - 314). Au hasard de nos recherches aux Archives Nationales et au Département des Manuscrits de la Bibliothèque Natio-

Sur ces derniers, 26 devaient devenir ingénieurs ce qui montre que la Commission comportait, à ses débuts, 58% d'ingénieurs, de futurs ingénieurs et de techniciens divers. En revanche, il y avait, au sens moderne du mot (42) tout au moins, seulement quatre savants : Berthollet, Fourier, Geoffroy Saint-Hilaire et Monge. Parmi les ingénieurs, l'un d'entre eux devait à la rigueur mériter ce titre plus tard : Michel-Ange Lancret.

Il est encore intéressant d'examiner la répartition des membres de la Commission dans les diverses classes d'émoluments : cela donne une idée de l'importance et de la considération dont jouissaient les intéressés à l'arrivée. Il semble du reste qu'en dehors des mérites affirmés et reconnus l'âge ait joué un certain rôle dans la répartition : ceci explique sans doute que parmi les artistes, le pianiste un peu bohème Villoteau âgé de trente-neuf ans ait été inscrit dans la première classe alors que Redouté, qui avait trente-deux ans, appartint à la quatrième. La plupart des ingénieurs, évidemment à cause de leur jeunesse furent inscrits dans la sixième classe et les élèves de l'Ecole polytechnique dans la septième. Ni les uns ni les autres ne furent très satisfaits de leur sort (43).

Nous avons enfin cherché quels étaient à l'arrivée en Egypte les âges des membres de la Commission. Pour les 87 pour lesquels nous possédions ce renseignement (44) nous sommes arrivés aux résultats suivants :

nale, nour avons glané un certain nombre de précisions complémentaires. Enfin, il y a quelques années, M. le Général Brisac, Commandant l'Ecole polytechnique, a bien voulu faire effectuer à notre demande dans les archives de cet établissement des recherches dont les résultats nous ont été obligeamment communiqués.

(42) A l'époque de l'Expédition il est vrai, le qualificatif de «savant» était attribué sans discernement par les militaires même aux plus jeunes membres de la Commission.

(43) Voir en particulier l'opinion de Dubois-Aymé à ce sujet (*CHE*, Sér. III, mars 1951, p. 230 - 231).

(44) Bien entendu ces membres sont presque toujours les plus attachants. Parmi ceux qui ont laissé une œuvre écrite et sur lesquels nous ne savons rien, nous ne citerons guère que Nectoux.

Ages	*Nombre*
de 10 à 14 ans	1
de 15 à 19 ans	10
de 20 à 24 ans	33
de 25 à 29 ans	13
de 30 à 39 ans	17
de 40 à 49 ans	7
de 50 ans et plus	6
Total	87

Le doyen de la Commission était Dominique Testevuide, âgé de plus de 62 ans, ingénieur en chef des géographes qui devait être tué le 30 vendémiaire an VII et le benjamin qui avait 12 ans Isidore Dubois, fils du chirurgien Antoine Dubois, futur accoucheur de l'Impératrice Marie-Louise.

L'âge moyen des 87 membres précédents était tout juste de 27 ans mais si l'on considérait seulement les ingénieurs et les futurs ingénieurs, la moyenne s'établissait seulement à 25 ans. D'autre part la moitié des membres recensés avait moins de 25 ans. C'est dire la jeunesse de tous ces personnages : ce point est fort important car il explique la facilité d'adaptation de tous ces jeunes gens à leur situation nouvelle et leur aptitude à s'attacher à des études entièrement neuves.

Au cours du séjour en Egypte, la composition de la Commission changea notablement. Tout d'abord vingt-cinq ou trente membres sans doute moururent (45) tandis que plus de vingt

(45) Moururent en Egypte ou en Syrie parmi les membres de la Commission qui n'étaient ni «artistes mécaniciens» ni imprimeurs: Bodard, Briguier, N. Champy, Charbaud, Coquebert, Dewesvres, Dulion, Duval, Fuseau, Gloutier, Joly, Leduc, Lerouge, Panhusen, Picquet, Saint-Simon ,Testevuide, Thévenod. Il faut ajouter à cette liste trois artistes mécaniciens: Cirot, Collin, Hérault, des imprimeurs dont nous ignorons le nombre exact. Nous savons pourtant que sur les 27 imprimeurs de notre *Liste nouvelle*, 14 seulement figurent sur l'Etat des rapatriés (Cf *ANF*, Carton F 17A 1.100). Sur les 13 autres nous sommes certains du décès en Egypte de Laporte, de Baudouin et de Besson. Nous avons donné ailleurs des précisions

s'embarquèrent prématurément pour la France ([46]). D'autres quittèrent la Commission à titre isolé pour entrer dans diverses Administrations ([47]). Les polytechniciens et les « élèves » devinrent ingénieurs ou sous-lieutenants ([48]). D'autre part et surtout, par application de divers décrets ([49]), les imprimeurs, les ingénieurs des ponts et chaussées et les ingénieurs géographes furent expressément détachés en bloc pour former des services distincts.

Cela explique que, dans *l'Annuaire de l'an VIII* ([50]), la Commission proprement dite ne comprenne plus que 42 membres, les ingénieurs des ponts et chaussées, les ingénieurs géographes et les constructeurs de vaisseaux figurant séparément. Plusieurs états nominatifs conservés à la Bibliothèque Nationale ([51]) et numériques de Vincennes ([52]) sont présentés de manière analogue, le nombre des membres de la Commission allant en diminuant sans cesse.

Dans l'*Annuaire de l'An IX* ([53]) en revanche, les Ingénieurs

complémentaires sur les membres de la Commission décédés en Egypte (*CHE*, 5e sér., déc. 1953, p. 298 - 300).

(46) Bessières, A. et I. Dubois, Gérard. Pouqueville, Porllier, Quenot et Roguin partirent dès les premiers mois. Norry, malade, quitta l'Egypte à la fin de 1798. Dolomieu et Cordier s'embarquèrent un peu plus tard. Berthollet, Denon, Jaubert, Monge et Parseval accompagnèrent Bonaparte. Corancez et Rigel firent une tentative vaine de regagner leur pays. Plus tard Ripault et, à la fin du séjour Costaz et Descotils purent arriver en France avant leurs collègues. Il en fut de même à des époques que nous ignorons de Bourgeois et de Greslé.

(47) Citons Corancez, Bernard et Pottier qui furent affectés à la Monnaie du Caire, Regnault et Hassenfrats qui firent partie de l'Administration des Droits de marque sur les ouvrages d'orfèvrerie. D'autre part Lévesque fut secrétaire de Menou et R.V. Pottier entra dans la Marine. Arnollet et Laroche furent Agents français etc...

(48) Cf. *CN*, Ordre No. 3.295 du 27 fructidor an VI et JS, 81 - 85. Les polytechniciens de la Commission qui entrèrent dans l'Armée furent Bouchard, Bringuier, Charbaud, Moret, Picquet, les élèves Fuseau et Vincent. Hyacinthe Le Père devint Commissaire des Guerres.

(49) Ces décrets datent du 29 fructidor an VII et du 19 nivôse an VIII. Les Circulaires d'Estève, No 74 de l'an VII, 32 et 33 de l'an VIII s'y réfèrent expressément.

(50) Pages 107 - 109.

(51) *NAF*, 21.950.

(52) AGV, Carton B⁶ 188.

(53) Pages 41 - 44.

figurent deux fois, séparément et au milieu des autres membres de la Commission dont la liste comprend 101 membres dont 12 absents. Cette présentation différente s'explique peut-être parce que les ingénieurs considérèrent qu'ils continuèrent toujours d'appartenir en fait au groupe. Aussi bien, tant après la signature de la Convention d'El Arish, à l'époque où il fut une première fois question sérieusement d'évacuation, qu'au moment du départ définitif de l'Egypte, la plupart des ingénieurs des ponts et chaussées et des ingénieurs géographes se joignirent aux naturalistes et aux artistes.

En juin 1801, quatre membres de la Commission ([54]), quatre ingénieurs des ponts et chaussées ([55]), cinq ingénieurs géographes ([56]) et vingt-trois imprimeurs ([57]) suivirent le sort de l'Armée Belliard. Le gros de la Commission et la majorité des ingénieurs, cinquante personnes ([58]) en tout, quittèrent le Caire le 7 Avril 1801 pour Alexandrie où elles s'embarquèrent sur *L'Oiseau* puis débarquèrent après des mésaventures bien souvent contées ([59]), mais parvinrent néanmoins à Marseille à la fin de 1801.



Les recherches dont nous venons d'exposer les résultats nous ont permis d'apporter des lumières nouvelles sur la composition de la Commission des Sciences et Arts d'Egypte. Certes, il subsiste encore et nous pensons qu'il subsistera sans doute toujours certaines incertitudes en la matière. Nous avons du moins établi que l'organisme avait, à ses débuts, compris environ 150 membres dont près des trois-cinquièmes étaient des ingénieurs, de futurs ingénieurs et des techniciens alors que les

(54) Dupuy, Dutertre J.B. Lepère, Villoteau (*ANF*, F 17A 1.100)

(55) Girard, Moline, Duchanoy et P.N. Pottier (Même source).

(56) Jacotin, Simonel et Faurie, anciens membres de la Commission d'une part, Lathuile et Schouani qui n'en avaient jamais fait partie d'autre part (Même source).

(57) Nous avons vu que sur ce nombre, 14 seulement figuraient sur la liste initiale.

(58) Sur les 50 membres du groupe, l'un d'eux, Lerouge mourut sous les murs d'Alexandrie. Jollois a donné la liste des 49 autres (*JI*, 138 - 139), confirmée par Redouté (*CMR*, XI, 60.)

(59) Cf. *JS*, 249 - 305 et *JI*, 138 - 160.

savants véritables étaient une poignée et les artistes guère plus nombreux de sorte qu'il serait conforme à la vérité historique de renoncer aux expressions de « savants de Bonaparte » ou « savants et artistes de Bonaparte » servant à désigner les membres de la Commission pour employer uniquement celle plus exacte de « savants et ingénieurs de Bonaparte ». Il convient de retenir aussi que l'âge moyen des membres de la Commission était environ de 27 ans, celui des ingénieurs étant plus bas encore. Cette jeunesse du groupement explique — avec les qualités intrinsèques de ses membres — l'ampleur des travaux réalisés dont nous aimerions donner plus tard une vue synthétique.

Annexe No. 1

ETAT RECAPITULATIF DRESSE EN VUE D'ETABLIR UNE LISTE NOUVELLE DES MEMBRES DE LA COMMISSION DES SCIENCES ET ARTS

Sur cet état figurent les noms et qualités des personnages considérés, précédés des numéros d'ordre de la **Liste nouvelle** de l'Annexe 2. On trouve ensuite l'indication des listes sur lesquelles les intéressés sont inscrits, les lettres ayant les significations suivantes :

A Liste des Archives
B Liste de floréal-messidor an VI
C Liste de prairial an VI
D Liste du 6 fructidor an VI
E Liste de messidor an VII
F Liste de l'Annuaire de l'an VIII
G Liste de l'Annuaire de l'an IX (1)
H Etat général de Vincennes
J Liste de Redouté
K Liste de 1823
L Liste de Reybaud
S Abréviation des Listes ABCDE
T Abréviation de la totalité des listes

Les noms des personnages ayant fait partie de la Commission à l'arrivée de l'Armée en Egypte sont en majuscules, ceux des élèves étant en italiques. Les autres noms sont en minuscules, ceux des hommes n'ayant pas quitté la France étant entre crochets.

Les nombres renvoient aux numéros de la **Liste nouvelle.**

ADNES, artiste mécanicien	T	113
ADNES fils, artiste mécanicien	T	114
AIME, artiste mécanicien	CDEFGHJKL	115
ALIBERT, polytechnicien	BCDGJKL	95
ANSIGLIONE, imprimeur	BCD	123

(1) Les absents en l'an IX sont indiqués par l'abréviation (G).

[Arnault], homme de lettres	L	178
ARNOLLET, élève des P.C.	SGJKL	84
BALZAC, Architecte	T	41
Barraud, secrétaire	L	180
[Barrier] imprimeur	A	152
Baudouin, imprimeur	BCDL	124
[Bauduin], dessinateur	AB	153
Beauchamp, astronome	HL	213
BELLETESTE, interprête	CDEGHKL	16
Benaben, littérateur	L	181
[Bénazet], ing. géographe	AB	154
BERNARD, élève des mines	ABCDJKL	55
BERTHOLLET, chimiste	S [G] HJKL	5
BERTRE, élève géographe	S GKL	65
BESSIERES, élève chirurgien	ABCDHKL	26
BESSON, imprimeur	ABCDL	125
BESSON, citoyenne	BCD	149
BODARD, ingénieur P.C.	ABCDKL	72
Bonjean, ing. const. vais.	L	214
BOUCHARD, polytechnicien	BCDJKL	96
BOUCHER, ing. const. vais.	ACDEGJKL	92
BOUDET, pharmacien	T	31
BOULANGER, imprimeur	ABCD	126
Boulouvard, élève	CD	182
BOURGEOIS, ing. géographe	SJKL	58
BOYER, imprimeur	ABCD	127
Bracévich, interprête	L	195
[Bréguet], horloger	A	155
BRINGUIER, polytechnicien	BCDJL	97
Brunet, dessinateur	C	183
Caquet, dessinateur du génie	L	206
CARISTIE, polytechnicen	BCDEGJKL	98
CARRE, imprimeur	BCD	128
[Cassard] artiste mécanicien	A	156
[Castéra,] imprimeur	A	157
CASTEX sculpteur	CDEFGHJKL	45

CECILE, ingénieur mécanicien	T	89
CHABROL, ingénieur P.C.	SGJKL	73
CHAMPY J.P. ingé. des poudres	T	86
CRAMPY N., élève des poudres	BCDEFGHJKL	87
CHARBAUD, polytechnicien	ABCDJL	99
CHAUMONT, ing. const. vais.	ACDEGJKL	93
[Chézy], ingénieur P.C.	A	158
CIROT, artiste mécanicien	SFJKL	116
COLLIN, artiste-mécanicien	CDEFGHJKL	117
CONTE, ing. mécanicien	AFGHJKL	90
COQUEBERT, botaniste	T	39
CORABOEUF, élève géographe	SGJKL	66
CORANIEZ, géomètre	AGHJKL	1
CORDIER, ing. des mines	ABCD [G] HJKL	53
COSTAZ, géomètre	T	2
Coutelle, officier aérostier	GHJKL	199
COUVREUR, artiste mécanicien	T	118
[Cruzy], imprimeur	A	159
Daburen, chirurgien	JL	184
DAMOUGEOT, imprimeur	BCD	129
DAMOUGEOT, citoyenne	BCD	150
[Dangos], astronome	A	160
[Debaudre], ingéneiur P.C.	A	161
DELAPORTE, interprête	CDGHKL	17
DELILE, botaniste	T	34
Demoulin, architecte	JL	185
DENON, littérateur	BCDE [G] HJKL	9
Derry, imprimeur	D	186
DESCOTILS, , ing. des mines	T	54
DESFOURS, artiste mécanicien	CDE	119
DEVILLIERS, polytechnicien	SGJKL	100
DEWEVRES, élève chirurgien	CDHJL	27
[Dizerand], imprimeur	A	162
DOLOMIEU, géologue	ABCD [G] JKL	35
DOMINICIS, imprimeur	BCD	130
DUBOIS A., chirurgien	ABC [G] HJKL	24

DUBOIS-AYME A., polytechnicien	SGJKL	101
DUBOIS I, élève chirurgien	ABCHJL	28
DUBOIS, imprimeur	ABCD	131
DUCHANOY, élève	ACDEGJKL	108
DULION, élève géographe	SJKL	67
Duperrey, dessin. du génie	JL	207
DUPUY, élève des mines	T	56
DUTERTRE, dessinateur	T	46
DUVAL, ingénieur P.C.	ABCDJKL	74
EBERHART, imprimeur	ABCD	132
FATALLA, interprète	BCDE	18
FAURIE, ing. géographe	SGKL	59
Fauvelet-Bourrienne, Secrétaire de Bonaparte	L	196
FAVIER, polytechnicien	SGJKL	102
Favre, artiste mécanicien	CD	187
FAYE, ingénieur P.C.	SGKL	75
PEVRE, ingénieur P.C.	SGJKL	76
FOUQUET, graveur	CDEFGHJKL	47
FOURIER, géomètre	T	3
FUSEAU, élève	CDJ	109
GALLAND, imprimeur	BCDL	133
GARREAU, imprimeur	CD	134
GEOFFROY, zoologue	T	36
GERARD, élève naturaliste	ABCHKL	40
GIRARD, ingénieur P.C.	SGJL	77
GLOUTIER, économiste	BCDFJL	12
[Gransart], imprimeur	A	163
GRESLE, ing. const. vais.	ACDGKL	94
HASSENFRATZ, artiste mécanicien	SKL	120
HERAULT, artiste mécanicien	BCDEFJKL	121
Hochu, artiste mécanicien	*Cour. Egypte No. 40*	210
JACOTIN, ing. géographe	BCDEGJKL	60
JARDIN, imprimeur	ABCD	135
JAUBERT, interprête	CD [G] HKL	19
JOLLOIS, ingénieur P.C.	SGJKL	78

JOLY, peintre	BHJKL	48
JOMARD E.F. élève géographe	SGJKL	68
Jomard J.B., élève	GKL	188
LABATTE, chirurgien	T	25
LACIPIERE, élève chirurgien	T	29
[Lafeuillade], ing. géographe	AB	164
[Laforie], imprimeur	A	165
LANCRET, ingénieur P.C.	SGJKL	79
Laporte, imprimeur	BCDJ	136
LAROCHE, élève géographe	ABCDGKL	69
Lathuille, officier géographe	L	202
[Laugier], imprimeur	A	166
[Le Blond], antiquaire	A	167
LEBRUN, poudres et salp.	CDEJ	88
LECESNE, élève géographe	SGJKL	70
LEDUC, ing. géographe	ABCDJKL	61
Leduc,, antiquaire	C	189
[Lemaître], horloger	A	168
LENOBLE, interprête	CDE	20
LENOIR, ing. mécanicien	T	91
LE PERE G., ingénieur P.C.	SGJKL	81
LE PERE H., élève	ABCD	110
LE PERE J. M., ingénieur P.C.	SGJKL	81
LEPERE J.B., architecte	CDEFGHJKL	42
Le Preux, minéralogiste	B	190
LEROUGE, littérateur	BCDEGHJKL	10
Le Roy, littérateur	BCD	191
LETHIOUX, imprimeur	ABCD	137
LEVESQUE, ing. géographe	ABCDEGKL	62
L'Homaca, interprête	L	197
Lhomont, off. aérostier	L	200
LINDEMANN, imprimeur	BCD	138
[Maizières], ing. mécanicien	A	169
MACCAGNI, imprimeur	BCD	139
Magallon, consul	L	211
Malus, officier du génie	JL	204

MARCEL, imprimeur	ABCDHKL	122
MARIEL, citoyenne	BCD	151
MARLET, imprimeur	ABCD	140
[Marquoy], imprimeur	A	170
Martin, ingénieur P.C.	GKL	209
MECHAIN, élève astronome	T	8
MESABKI, imprimeur	BCD	141
Michelet, artiste mécanicien	B	192
[Milbert] naturaliste	A	171
MOLINE, polytechnicien	CDEGJKL	103
[Mollard] ing. mécanicien	A	172
MONGE, géomètre	S [G] HJKL	4
MORET, polytechnicien	BCDJL	104
Mouthiers, interprête	BCD	193
NECTOUX, botaniste	T	37
[Nepveu] naturaliste	A	173
NORRY, architecte	ABCD [G] HJKL	43
NOUET, astronome	T	6
PANHUSEN, interprête	ABHJKL	21
PARSEVAL, littérateur	BCDE [G] HJKL	11
PELLEGRINI, imprimeur	BCD	142
PICQUET, polytechnicien	ABC	105
Plane, pharmacien	J	212
Plazanet, officier aérostier	L	201
[Poncelet], imprimeur	A	174
Portal, dessinateur du génie	JL	208
POTTIER, P.N., polytechnicien	ABCGJKL	106
POTTIER R.V., élève géographe	ABCDL	71
POUQUEVILLE, élève chirurgien	ABCDHKL	30
POURLIER, antiquaire	ABCD [G] HJKL	14
PROTAIN, architecte	T	44
PUNTIS	ABCDL	143
QUENOT, astronome	ABCD [G] HJKL	7
RAFFENEAU, élève P.C.	ABCDGJKL	85
RAIGE, interprête	CDGHJKL	22
[Ramelet], imprimeur	A	175

REAL, interprête	BCD	23
REDOUTE, peintre	T	49
REGNAULT, polytechnicien	SFGJKL	108
[Regnault de Saint Jean d'Angely]	L	179
RENNO, imprimeur	BCD	144
RIGEL, pianiste	CDEFGHJKL	50
RIGO, peintre	T	51
RIPAULT, élève antiquaire	S [G] HJKL	15
RIVET, imprimeur	ABCD	145
ROGUIN, pharmacien	ABCDHL	32
ROSELLI, imprimeur	BCD	146
ROUYER, pharmacien	T	33
ROZIERE élève des mines	T	57
RUGUA, imprimeur	BCD	147
SAINT-GENIS, ingénieur P.C.	SGJKL	82
SAINT - SIMON, anc. chevalier de Malte	DJ	13
SAVIGNY, zoologue	T	38
SAY, officier du génie	L	205
Schouani, officier géographe	L	203
SIMONEL, ingénieur géographe	BCDEGJKL	63
Tallien, politicien	L	215
TESTEVUIDE, ingénieur géographe	BCDJKL	64
THEVENOD, ingénieur P.C.	ABCDJKL	83
[Thouin], naturaliste	A	176
[Thomas], horloger	A	177
Touray, interprête	B	194
Venture, interprête	HJL	198
VERY, imprimeur	ABC	148
VIARD, élève	SFGJKL	111
VILLOTEAU, musicien	CDEFGHJKL	52
VINCENT, élève	SFJKL	112
Vincent, ing. const. vais.	L	216

Annexe No. 2

LISTE NOUVELLE DES MEMBRES DE LA COMMISSION DES SCIENCES ET ARTS A L'ARRIVEE EN EGYPTE

L'on a donné successivement pour chaque personnage cité, un numéro d'ordre, le nom et les prénoms, les années de naissance et de décès. Les chiffres entre parenthèse indiquent la classe d'émoluments, la lettre M que l'intéressé est mort en Egypte ou en Syrie, la lettre P qu'il est parti avant le gros de l'armée.

Les noms des élèves sont en italiques.

4 Géomètres

1 CORANCEZ, Louis - Alexandre - Olivier de - (1770 - 1832) (?)
2 COSTAZ, Louis (1767 - 1842) (1) P
3 FOURIER, Jean - Joseph (1786 - 1830) (1)
4 MONGE, Gaspard (1746 - 1818) (1) P

1 Chimiste

5 BERTHOLLET, Claude - Louis (1748 - 1822) (1) P

3 Astronomes

6 NOUET, Nicolas - Auguste (1740 - 1811) (2)
7 QUENOT, François-Marie (1761 - ?) (2) P
8 *MECHAIN*, Jérome - Isaac (1778 - 185) (7)

3 Littérateurs

9 DENON Dominique - Vivant (1747 - 1825) (2) P
10 LEROUGE (4) M
11 PARSEVAL de GRANDMAISON, François - Auguste (1759 - 1834) (1) P

1 Economiste

12 GLOUTIER, Alexis (1758 - 1800) (2) M

1 Ancien Chevalier de Malte

13 SAINT - SIMON, André - Louis de - (17 - 1799) (7) M

2 Antiquaires

14 POURLIER (4) P
15 *RIPAULT*, Louis - Madeleine (1775 - 1823) (6) P

8 Interprêtes

16 BELLETESTE, Henri-Nicolas (1778 - 1808) (6)
17 DELAPORTE, Jacques - Denis (1777 - 1861) (6)
18 FATALA, Elias (3)
19 JAUBERT, Pierre - Amédée - Probe (1779 - 1847) (6) P
20 LENOBLE (5)
21 PANHUSEN (17 - 1798) (4) M
22 RAIGE, Louis - Rémy (1777 - 1810) (6)
23 REAL (6)

7 Chirurgiens

24 DUBOIS, Antoine (1765 - 1836) (1) P
25 LABATTE, Joseph - Jean - Jacques (1766 - 1835) (2)
26 *BESSIERES*, Henri - Gérard - Julien (1772 - 1840) (7) P
27 *DEWEVRES* (17 - 1799) (6) M
28 *DUBOIS* Isidore (1786 - 18) (7) P
29 *LACIPIERE* (1777 - 18) (7)
30 *POUQUEVILLE*, François - Charles - Hugues - Laurent (1770 - 18) (7) P

3 Pharmaciens

31 BOUDET, Jean - Pierre (1748 - 1828) (1)
32 ROGUIN (6) P
33 ROUYER Pierre-Charles (1769 - 1831) (6)

7 Naturalistes

34 DELILE Alix RAFFENEAU (1778 - 1850) (2)
35 DOLOMIEU Déodat - Gui - Sylvain - Tancrède GRATET de - (1750 - 1801) (1) P
36 GEOFFROY SAINT - HILAIRE Etienne (1772 - 1844) (1)
37 NECTOUX, Hippolyte (5)
38 SAVIGNY, Marie - Jules - César LELORGNE de - (1777 - 1851) (6)
39 *COQUEBERT de MONTBRET*, Antoine - François - Ernest (1760 - 1801) (6) M
40 *GERARD*, Alexandre (7) P

4 Architectes

41 BALZAC, Charles - Louis (1752 - 1820) (3)
42 LEPERE, Jean - Baptiste (1761 - 1844) (2)
43 NORRY, Charles (1756 - 1832) (1) P
44 PROTAIN Jean - Constantin (1746 - 1832) (3)

8 Artistes

45 CASTEX, Jean - Jacques (17 - 1822) (3)
46 DUTERTRE, André (1753 - 1842) (1)
47 FOUQUET, Pierre - Denis (3)
48 JOLY (17 - 1798) (7) M
49 REDOUTE, Henri - Joseph (1766 - 1852) (4)
50 RIGEL, Henri - Jean (1772 - 1852) (1)
51 RIGO Michel (17 - 1815) (3)
52 VILLOTEAU, Guillaume - André (1759 - 1839) (1)

5 Ingénieurs des Mines

53 CORDIER, Pierre - Louis - Antoine (1777 - 1861) (5) P
54 DESCOTILS Hipolyte - Victor COLLET - (1773 - 1815) (3) P
55 *BERNARD* Samuel (1776 - 185) (6)
56 *DUPUY* Victor (1777 - 1861) (6)
57 *ROZIERE* François - Michel (1775 - 184) (6)

14 Ingénieurs Géographes

58 BOURGEOIS, Louis - Jacques (5) P
59 FAURIE (5)
60 JACOTIN Pierre (1765 - 1827) (4)
61 LEDUC (17 - 1799) (5) M
62 LEVESQUE (5)
63 SIMONEL, Pierre (4)
64 TESTEVUIDE Dominique (1736 - 1798) (1) M
65 *BERTRE* Jacques - Antoine (1776 - 18) (6)
66 *CORABOEUF* Jean - Baptiste (1777 - 18) (6)
67 *DULION* Jacques - Auguste (17 - 1799) (6) M
68 *JOMARD* Edme - François (1778 - 1862) (6)
69 *LAROCHE* François (1778 - 18) (6)
70 *LECESNE,* Bienheureux - Désiré - François REEL - (1772 - 1827) (6)
71 *POTTIER* Roland - Victor (1775 -) (6)

14 Ingénieurs des Ponts et Chaussées

72 BODARD, Louis - Victor (1745 - 1799) (2) M
73 CHABROL de VOLVIC, Gilbert - Joseph - Gaspard - Antoine (1778 - 1843) (5)
74 DUVAL Léonard (1768 - 1798) (5) M
75 FAYE Hervé - Charles - Antoine (1763 - 1825) (5)
76 FEVRE Jean - Baptiste (1775 - 1850) (5)
77 GIRARD, Pierre - Simon (1765 - 1836) (2)
78 JOLLOIS, Jean - Baptiste - Prosper (1776 - 1842) (5)
79 LANCRET, Michel - Ange (1774 - 1807) (5)
80 LE PERE, Gratien (1769 - 1832) (5)
81 LE PERE, Jacques - Marie (1763 - 1841) (2)
82 SAINT GENIS, Alexandre BOURGES - (1772 - 1834) (5)
83 THEVENOD, Claude - François (1772 - 1798) (5) M
84 *ARNOLLET* Pierre - Jean - Baptiste (1776 - 1857) (6)
85 *RAFFENEAU-DELILE,* Adrien (1773 - 1843) (6)

3 Poudres et Salpêtres

86 CHAMPY, Jacques - Pierre (17 - 1816) (1)
87 *CHAMPY,* Jean - Nicolas (1777 - 1801) (7) M
88 *LE BRUN* 17 - 1802) (7)

3 Ingénieurs mécaniciens

89 CECILE, François - Michel (1766 - 18) (3)
90 CONTE Nicolas - Jacques (1755 - 1805) (?)
91 LENOIR Paul - Etienne - Marie (1776 - 1826) (6)

3 Ingénieurs constructeurs de vaisseaux

92 BOUCHER, Mathurin - François (1778 - 1851) (6)
93 CHAUMONT, Jean - François (6)
94 GRESLE, Philippe (1776 - 18) (6) P

13 Elèves Ecole Polytechnique

95 *ALIBERT,* Bertrand (1775 - 1808) (7)
96 *BOUCHARD,* Pierre - François - Xavier (1772 - 1832) (7)
97 *BRINGUIER,* Jean - Balthazar (1777 - 1799) (7) M
98 *CARISTIE,* Philippe - Jean - Marie (1775 - 1852) (7)
99 *CHABAUD,* Jean-Louis (1780 - 1799) (7) M

100 *DEVILLIERS du TERRAGE,* Edouard - René (1780 - 1855) (7)
101 *DUBOIS-AYME,* Jean - Marie - Joseph - Aimé DUBOIS dit - (1779 - 1846) (7)
102 *FAVIER,* Louis - Joseph (1776 - 1855) (7)
103 *MOLINE de SAINT-YON,* Benoît (1782 - 1842) (7)
104 *MORET SAINT-AMAND* (1780 - 18) (7)
105 *PICQUET* Jean-Baptiste (17 - 1799) (7) M
106 *POTTIER* Paul - Nicaise (1778 - 1842) (7)
107 *REGNAULT* Joseph - Angélique - Sébastien (1776 - 1827) (7)

5 Elèves

108 DUCHANOY, Louis (1781 - 1954) (7)
109 *FUSEAU de SAINT-CLEMENT* (17 - 1799) (7) M
110 *LE PERE,* H. (7)
111 *VIARD,* Joseph - Antoine (1783 - 1849) (9)
112 *VINCENT,* Louis - François (1780 - 18) (9)

9 Artistes mécaniciens

113 ADNES, Pierre - Onésime (1760 - 18) (3)
114 ADNES fils (6)
115 AIME (3)
116 CIROT, Calixte - Victor (4) M
117 COLLIN (6) M
118 COUVREUR (4)
119 DESFOURS (3)
120 HASSENFRATZ (6)
121 HERAULT, François - Michel (17 - 1800) (3) M

27 Imprimeurs

122 MARCEL (1)
123 ANSIGLIONE (7)
124 BAUDOUIN (6) M
125 BESSON (6) M
126 BOULANGER (6)
127 BOYER (6)
128 CARRE (6)
129 DAMOUGEOT (6)
130 DOMINICIS (7)
131 DUBOIS (6)
132 EBERHART (5)
133 GALLAND (5)
134 GARREAUX (6)
135 JARDIN (6)
136 LAPORTE (5) M
137 LETHIOUX (6)
138 LINDEMANN (6)
139 MACCAGNI (7)

140 MARLET (6)
141 MESABKI (6)
142 PELLEGRINI (7)
143 PUNTIS (4)
144 RENNO (7)
145 RIVET (6)
146 ROSELLI (7)
147 RUGUA (7)
148 VERY (6)

3 Citoyennes

149 BESSON (10)
150 DAMOUGEOT (10)
151 MARIEL (8)

26 Personnes demeurées en France

152 BARRIER
153 BAUDOIN
154 BENAZET
155 BREGUET
156 CASSARD
157 CASTERA
158 CHEZY
159 CRUZY
160 DANGOS
161 DEBAUDRE
162 DIZERAND
163 GRANSART
164 LAFEUILLADE
165 LAFARIE
166 LAUGIER
167 LEBLOND
168 LEMAITRE
169 MAIZIERE
170 MARQUOY
171 MILBERT
172 MOLLARD
173 NEPVEU
174 PONCELET
175 RAMELET
176 THOUIN
177 THOMAS

2 Personnes restées en Egypte

178 ARNAULT
179 REGNAUD de SAINT - JEAN d'ANGELY

15 cas douteux

180 BARRAUD
181 BENABEN
182 BOULOUVARD
183 BRUNET
184 DABURON
185 DEMOULIN
186 DERRY
187 FAVRE
188 JOMARD J.B.
189 LEDUC
190 LE PREUX
191 LEROY
192 MICHELET
193 MOUTHIERS
194 TOURAY

22 Personnes considérées comme n'ayant pas appartenu à la Commission à l'arrivée de l'armée en Egypte

Quartier général

195 BRACEVICH
196 FAUVELET - BOURRIENNE
197 L'HOMACA
198 VENTURE M

Officiers aérostiers

199 COUTELLE
200 LHOMONT
201 PLAZANET

Officiers géographes

202 LATHUILE
203 SCHOUANI

Officiers du génie

204 MALUS
205 JAY M

Dessinateurs du génie

206 CAQUET M
207 DUPERREY M
208 PORTAL M

Administrateurs ou isolés

209 MARTIN
210 HOCHU
211 MAGALLON
212 PLANE

Arrivés après le gros de l'armée

213 BEAUCHAMP
214 BONJEAN
215 TALLIEN
216 VINCENT

AN OUTLINE OF THE GEOLOGIC STRUCTURE OF THE BIR EL HALEIFIYA - GEBEL EL ZEITA AREA

(The West Sinai Foreshore Province, Egypt)

by

A. SHATA
Geology Section, Desert Institute

INTRODUCTION

The Bir El Haleifiya — Gebel El Zeita area (approximately 150 sq. km.) is situated in the northern portion of the West Sinai Foreshore Province. This area lies about 60 km. to the south-east of Suez and is easily accessible by light and medium cars. On the east, it is bounded by the Eocene flat topped hills of Gebel El Raha, and to the west there exists the new oil fields region which was discovered at Sudr, Asl and Ras Matarma (Fig. 1).

Within the Bir El Haleifiya — Gebel El Zeita area there are some of the conspicuous topographic features which characterize the southern portion of the great plain extending from the Bitter Lakes region to Gebel Hammam Faraun (Shata, 1955). As elsewhere in West Sinai, the tectonic forces, with faulting rather than folding, have a strong influence on the land forms of this area

The detailed study of the geology of the Bir El Haleifiya — Gebel El Zeita area was made by the writer early in 1953. The work which was undertaken, included the measurement of the stratigraphic succession, the construction of a geologic map and the investigation of the structure.

At Bir El Haleifiya — Gebel El Zeita, the whole area is occupied by sedimentary rocks and the succession has a thickness of about 1300 m. From top to base this succession is summerized as follows :

4) *MIDDLE MIOCENE* (360 m.)

b) Reefal series ; fossiliferous limestone . . . . 150 m.
b) Lagoonal series ; shale, anhydrite and gypsum . . 205 m.

3) *OLIGO-MIOCENE* (570 m.)
e) Unit 5, fossiliferous marl .... 100 m.
d) Unit 4, gypsum, marl and limestone .... 115 m.
c) Unit 3, alternating marl and sandstone .... 260 m.
b) Unit 2, gypseous shale .... 160 m.
a) Unit 1, Sandy marl with fossils .... 35 m.

2) *UPPER EOCENE* (230 m. +)
c) Clastic series; fossiliferous marl and shale .... 110 m.
b) Chalky series; unfossiliferous chalky limestone 120 m.
a) Covered interval .... ? m.

1) *MIDDLE EOCENE* (? m.)
Nummulitic limestone.

In this paper it is aimed to give an outline of the geologic structure of the Bir El Haleifiya — Gebel El Zeita area. This will include a brief discussion of the regional structural setting of that area and also an analysis of the detailed structure.

REGIONAL STRUCTURAL SETTING

The regional structure of the Bir El Haleifiya — Gebel El Zeita area, as revealed by Figs. 2, 3, 4 and 5, is strongly affected by faulting. Crescentic fault blocks, which are related to the rift faulting that formed the Gulf of Suez depression, are the conspicuous features known in that area. All the mapped faults are normal and are the result of tensional forces. True folds, which are a criteria of compression, are not present.

Within this area, there are two systems of faulting. These, are almost perpendicular and were presumably formed contemporaneously. The first, and the rather important of these two systems, has a NW - SE strike and runs parallel to the main Gulf of Suez depression. The faults of this system belong to the main group of major faults bounding that depression from the eastern side. These faults were recognized and described by several workers who visited the region, and much was said about their nature, their age and the mechanism which account for their formation. All the details concerning the various related problems could be found in the literature (Ball, 1910, 1911, 1916; Bowman, 1931; Busk, 1929; Hume, 1906; Moon and Sadek, 1921, Sadek, 1925, Shata, 1954, Tromp, 1950).

The major faults, which were mapped in the Bir El Haleifiya — Gebel El Zeita area, continue far south towards and beyond the southern extremity of Gebel Khosheira (Fig, 3 & 4). As shown in Fig. 3, these faults run parallel to the great El Raha - El Tih fault line. Between this line of faulting and the gulf coast, at least three major parallel fault lines are detected. These parallel faults divide the strata into a corresponding number of steps of vertical blocks with the downthrow sides almost to the west. Local exceptions, where the downthrow side is to the east, are known. The resulting blocks, are tilted away from the center of the main graben and represent a series of step faults where each step has successively been raised higher.

Arranged from east to west, the following main fault blocks are known :

1) El Raha - El Tih Stable Block ; composed essentially of Cretaceous strata (Eocene outcrops appear only in the northern portion). The mean elevation of this block exceeds 500 m. (A.S.L.) *
2) El Raqaba - El Abyad Block ; composed essentially of Middle Eocene strata. The mean elevation of this block is less than 500 m. (A.S.L.).
3) El Zeita - Khosheira - El Mreir Block ; or the first Miocene block. This is composed of Oligo-Miocene and Middle Miocene strata, and its mean elevation is about 400 m. (A.S.L.).
4) Asl - Nebwi Block ; or the second Miocene block, composed essentially of Middle Miocene strata, and the mean elevation is ± 200 m. (A.S.L.).
5) There is undoubtedly another block which occupies the coastal strip but it is masked underneath the Recent sand and gravel cover. The "Coastal Block", as here will be referred to, has an elevation much lower than 100 m. (A.S.L.).

The Bir El Haleifiya - Gebel El Zeita area occupies only the northwestern extremity of "El Zeita - Khosheira - El Mreir Block » or the first Miocene block.

The formation of these fault blocks took place through a number of stages, the age of which cannot be determined with certainly from the study of such a small area. However, facts from the wider Gulf of Suez region, indicate that tectonic movements on a large scale, only took place in Oligocene times

(*) A.S.L. Above Sea Level.

(Blanckenhorn, 1921 ; Shukri, 1953 ; Shukri and Akmal 1953 ; Stainforth, 1949). These movements were rejuvenated in post-Miocene times, essentially during the Plio-Pleistocene (Knebel and Weeks, 1947),* and were responsible for the present day physiographic pattern of the entire Gulf of Suez region.

In the Bir El Haleifiya — Gebel El Zeita area, there is another system of step faults which also has an effect on its morphology. The faults belonging to this system have a NE-SW strike and represent simple fracture lines, perhaps due to local adjustment, along the major NW-SE faults.

At Bir El Haleifiya - Gebel El Zeita area minor local folding has been noted at some places, but this is essentially due to the bending of the strata before they finally break down under the strain which produced the different fracture lines.

A study of the geological structure of the Bir El Haleifiya - Gebel El Zeita area becomes, therefore, a study of its fault pattern which has the most influence on the present land forms.

In the following pages it is intended to consider the individual faults and to record their characters, their direction and the rocks which they affect.

DETAILED STRUCTURAL SETTING

Arranged from east to west the different faults, which govern the structure of the Bir El Haleifiya - Gebel El Zeita area, are tabulated as follows :

1) El Haleifiya — Ruin fault F1
2) El Haleifiya - Raqa fault F2
3) West El Haleifiya faults .... F3a and F3b
4) East Khosheira fault F4
5) West Khosheira fault F5
6) West El Zeita faults .... F6 a-d (inclusive)

We will now proceed to deal with each one of these faults.

1) El Haleifiya — Ruin Fault (F1)

This fault is the most easterly fracture known in the area. It runs in a NW-SE direction for a distance of about 12 km. and was traced almost accurately except in places where the bounding rocks become masked underneath the alluvium and gravel cover. This fault has its upthrow side to the east.

(*) Unpublished work for the Standard Oil Company of Egypt, 1947.

Outside this area to the south, this fault extends in a southeastern direction for 8 km. where it joins the "Eocene scarp fault" described by Moon and Sadek (1925). Its total length becomes therefore about 20 km. This fault is not a straight line, but when followed, it was found to make a series of irregular curvatures (Fig. 4). It dissects the southwestern portion of "El Raqaba - El Abyad Block" into two unequal parts ; a major one lying to the east and a narrow and elongate one lying to the west.

The oldest rocks exposed on the upthrow side of this fault are of Middle Eocene age (Nummulitic limestone series). These occupy the southeastern portion of the mapped area and are in juxtaposition with the Upper Eocene "Chalky Series".

Close to the point where the Ruins of an old Turkish fort are present (11 L & M, fig. 5), the amount of vertical throw of this fault has been estimated as approximately 300 m. This amount, increases gradually in a southeast direction to a maximum of 400 m. (beyond the limit of the map), and then starts to decrease again in the same direction. To the northwest, the amount of vertical throw also decrease gradually untill the fault dies out in the area just to the north of Bir El Haleifiya (K 2 & K 3, Fig. 5).

The Middle Eocene rocks, which are exposed on the upthrow side of the fault, dip regionally in an eastward direction at the average rate of 5°. But to the north of the "Ruins" (L9, M9 Fig. 5), these beds are rapidly bent into the southwest direction towards the fault itself with the development of a local structural closure.

Towards the northwestern end of this fault, it passes in close proximity to Bir El Haleifiya (Water well, K3 Fig. 5). This fault may accordingly be regarded as responsible for the accumulation of the limited amount of water now produced by that well.

2) El Haleifiya — Baqa Fault (F2)

This fault lies to the the west of F1 at a distance varying between 500 m. and two kilometers. It has a length of about 10 km. and runs in an almost north-south direction. Beyond the limit of the mapped area, this same fault extends in a southeastward direction for at least 20 kilometers (Figs. 3 & 4).

This major fault has its upthrow side to the east and is mainly responsible for the separation of the Eocene Block

(El Raqeba - El Abyad Block) from the first Miocene Block (El Zeitar - Khosheira - El Mreir Block (Fig. 3). The southern portion of "El Haleifiya - Baqa fault," coincides with the "West Wadi Silfa Fault" which was described by Moon and Sadek, (1925). All along the length of this fault, no difficulty has been found in locating its position and on both its sides the strata appear as if they were cut with a sharp knife.

The oldest rocks exposed on the upthrow side of this fault belong to the Upper Eocene period. These are restricted to the eastern portion of the map and dip regionally in a northwest direction at the average rate of 10°. Following on top of the Upper Eocene formations, strata belonging to the lowest Oligo-Miocene succession, appear in a narrow and elongate strip extending from Wadi El Sir (a tribulary of Wadi Wardan) to the approaches of Bir El Haleifiya. The attitude of these beds is to the west at the rate of 15° and 20°.

The maximum amount of vertical throw of this fault has been roughly estimated as 600 m., (upthrow side to the east). This amount, which is attained close to the southern edge of the map, decreases gradually in a northward direction until it becomes approximately 300 m. at the point where the fault joins "El Haleifiya - Ruin Fault", F1 (K3, Fig. 5).

The "Fault slice" included between F1 and F2 is interesting from the structural stand point but the magnitude of the resulting structure, (closure along the fault), cannot be determined.

3) West El Haleifiya Faults (F3a and F3b)

These two faults are almost parallel, run in a NW-SE direction and have a strong influence on the landscape of the northeastern portion of the mapped area. These faults govern essentially the formation of the three successive ridges occupying the area to the west of Bir El Haleifiya and cause the repetition of the same geological formations which they bound. These two faults have the upthrow side to the west, and in this respect they differ from Fl and F2 where the upthrow sides are to the east.

F3a bounds the easterly ridge from the southwestern side and its position was located almost accurately through a distance of 3 km. This fault is not a straight line, but similar to the other faults it forms a series of curvature.

The southeastern end of this fault joins probably F1 at a point lying approximately 200 m. to the south of Bir el Haleifiya (K3, Fig. 5). As to the other end, this fault still extends beyond the limit of the area to the north.

At one locality the hade of this fault was measured as 68° dipping to the northeast and the amount of vertical throw was estimated as about 100 m.

The principal structural feature of the ridge occuying the dowthrow side of the fault is a conspicuous sharp syncline which is oriented in a NW - SE direction, i.e. parallel to the fault itself. The Upper layers which occupy the synclinal area belong to "Unit 5" of the "Oligo-Miocene Series", and dip in opposite direction at an average rate 15° to 20°. A short distance to the west of this synclinal feature and parallel to it, a sharp anticline was detected before the fault line has been reached. The sharp anticlinal and synclinal features are presumably associated with the faulting phenomenon, i.e. they have resulted from the relative bending of the strata before they were broken under the strain effect of the fault.

F3b lies to the west of F3a at a distance varying between 1 km. and 1.5 km. and extends more to the south where its runs parallel to F1 and F2. The length of this fault is about 4 km. and the upthrow side is to the west. The fault block included between the two faults (F3a and F3b) is tilted to the west (cross section BB, Fig. 4); but at some localities reverse dips are apparent and a synclinal feature is developed. The beds which constitute this block belong to "Units 4 and 5" of the Oligo-Miocene series.

The oldest beds exposed on the upthrow side of this fault (F3b) belong to "Unit 4" of the Oligo-Miocene series. These occupy a narrow and elongate strip and form a magnificent structural closure along the fault. This structural feature has a NNW - SSE trend (13, 14 Fig. 5) and is approximately 1 km. long and less than 200 m. wide, and has an area of about 0.25 sq. km.

4) East Khosheira Fault (F4)

This fault effects the southern portion of the mapped area, bounds the northern extremity of the main Khosheira massif from the eastern side and runs almost parallel to the foot of the hill mass which is separated from the Wadi Baqa plain lying to the east. This fault was not accurately located owing to the

occurence on the surface of thick alluvial and colluvial deposits. Its existence was, however, indicated from the study of the arrangement of the strata which are locally exposed on both sides.

Within the mapped area this fault runs in a NW-SE direction for a distance of 3 km. and extends southeastwards for at least two kilometers. It is more inclined to the west than F1 and F2.

The upthrow side of this fault is to east and on this side there is exposed a covered interval envolving probably "Units 1-4" of the Oligo-Miocene series. On the other side we have better exposures of "Units 4 and 5" of the same series. At one locality the strata are suddenly bent into the fault and important structural closure is obtained. On top, the Oligo-Miocene beds are followed by the "Lagonal and Reefal" series of the Middle Miocene period which enter into the formation of the main Khosheira massif. The northwestern portion of that structure (L 12 & 13, Fig. 5), is only included in our map while the rest, i.e. the southeastern portion is well shown on the map of Moon and Sadek (1925). The dimensions of this closure are approximately 2 km. by 200 m.

5) West Khosheira Fault (F5)

This fault lies almost parallel to F4 and affects the western side of the main Khosheira massif. The portion of this fault which is included in our area represents the northwestern extension of the "Wadi Nikheila fault" described by Moon and Sadek (1925). The main fault, having a length of at least 20 km., bounds "El Zeita - Khosheira - El Mreir Block" from the western side. It runs in a NW-SE direction and its upthrow side is to the east. Similar to F1 and F2, it makes several irregular curvatures.

On the upthrow side of this fault, the "Middle-Miocene Lagonal Series", are exposed and constitute the western flank of the main Khosheira massif. These formations rise gradually up and are followed on top by the weather resistant Middle Miocene "Reefal limestone." On the down throw side of the fault, the "Reefal Series" are exposed and form the surface of the low flat plain which occupies the southwestern corner of the map and which extends for several kilometers outside the area to the west.

The maximum amount of vertical throw of this fault is

approximately 150 m. This amount is attained at the southern extremity of the mapped area (E 13, Fig. 5) but it then decreases gradually in the northwestern direction until the fault dies out somewhere at the southern edge of Wadi Wardan (D9, Fig. 5).

6) West El Zeita Faults (F6 a-d)

To the west of the main Gebel El Zeita the exposed strata belonging essentially to the Middle Miocene period, are dissected by four important antethetic faults (F 6 a-d). These faults run in a NE-SW direction and terminate to the north "El Zeita - Khosheira - El Mreir fault block," (Fig. 3). The type of the above mentioned faults is odd to the Gulf of Suez region and is thought to represent simple fracture lines resulting from the relaxation of the strata along the major faults which are dominant in the region and which are oriented in a NW-SE direction.

When mapping the central portion of the Bir El Haleifiya - Gebel El Zeita area, it was sometimes practiced very difficult to trace these new faults. This is mainly attributed to the fact that the gypsum beds, which are dominant in that particular portion of the map, form when wheathered lava like crusts and mask the surrounding formations.

F6 a, the most easterly fault, bounds the main Gebel El Zeita ridge from the northwestern side, and was followed for a distance of about 4 km. This fault runs in a NE-SW direction and its upthrow side is to the east. The maximum amount of vertical throw of this fault is approximately 2270 m., (Cross Section CC' Fig. 5). On the upthrow side, strata belonging to the upper most portion of the Oligo-Miocene Series are exposed, and occupy a very narrow and elongate strip. On the other side of the fault, Middle Miocene formations with reefal limestone beds on top and gypsum beds below, are found. The attitude of these formations is to the east, i.e. towards the fault itself. On the upthrow side of this fault a small structural closure is developped.

F6 b lies to the west of F 6a at a short distance varying between 500 m. and one kilometer and is almost parallel to it. The length of this fault, which runs also in a NE-SW direction is approximately 4 km. The amount of vertical throw is about 170 m., (down-throw side to the west). Similar to F 6a this amount decreases gradually towards both ends of the fault. On

the upthrow side, the gypsum beds of Middle Miocene age are exposed and on the other side, good exposures composed mainly of "Reefal limestone" are found and form an elongate ridge tilted towards the fault.

F 6c is the third fault belonging to this set of antethetic fractures and is apparently the most important one of them as it bounds the major "El Zeita - Khosheira - El Mreir Block" from the northwestern side. This fault was traced from a point located at the northern edge of Wadi Wardan (E 8, Fig. 5) to another point at the southern edge of Wadi Somar (G4, Fig. 5), i.e. a distance of about 5 km. There is a strong possibility that this same fault is still continued northeastward underneath the superficial gravel and boulder layers which fill the main drainage of Wadi Somar. If this is true, the length of this fault, as far as our area is concerned, becomes about 8 km. Further northwest, this fault is still extended beyond the limit of map. The maximum amount of vertical throw of this fault is about 400 m., but similar to the other two faults, this amount decreases towards the ends. The oldest beds exposed on the upthrow side of this fault belong to the Oligo-Miocene series and these are brought in juxtaposition with the Middle Miocene "Reefal Series", (H 1, Fig. 5).

F 6d is the most westerly fracture belonging to this set of antethetic faults. It was not studied accurately in the field owing the occurence of secondary gypsum and gravel layers on the surrounding formations. But, similar to the other faults it runs in a NE - SW direction and its upthrow side is to the east. At one locality along this fault the amount of vertical throw was estimated as about 150 m.. This amount decreases presumably towards both its extremities.

GEOLOGIC HISTORY

The general outline of the gelogical history of the Bir El Haleifiya - Gebel El Zeita area represents only a limited portion of the much wider history of the main Gulf of Suez region. This has been discussed in some detail by sevral workers of whom we mention Barron, 1907 ; Sadek, 1926 ; Bowman, 1931 ; Picard, 1943 ; Stainforth * 1948 ; Tromp, 1951 and Shata, 1953.

The succession of the main tectonic events leading up to

(*) Unpublished work for the Standard Oil Company of Egypt, 1948.

the present day structural configuration of this wide region is almost represented in the Bir El Haleifiya - Gebel El Zeita area. Without going into details the following is a condensed summary :

(1) Most authors are of the opinion that the development of the Gulf of Suez region is based on faulting. The northern portion of this region is slightly touched by the NE - SW structural belt of folding affecting strongly North Sinai. Primary faulting occurred in pre-Miocene times (presumably during the Middle Oligocene). These faults were accentuated in post-Miocene times (essentially during the Plio-Pleistocene). All the faults are normal and are the result of tensional forces.

(2) El Zeita - Khosheira - El Mreir fault block as well as the other minor blocks attached to it, became morphologically developped in post-Miocene times.

(3) Following to the rising of these blocks, intensive erosion took place mainly with the commencement of the Quaternary with the result that the drainage system and the present day physiographic pattern took on much of their shape.

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RAPPORT

SUR LES ACTIVITES DE L'INSTITUT D'EGYPTE

SESSION 1954-1955

SEANCES. — L'Institut a tenu, au cours de cette session, sept séances, dont deux supplémentaires.

PUBLICATIONS. — L'Institut a publié, pendant le courant de l'année, le Bulletin t. XXXVI. fasc. 1 et 2.

ECHANGE DE PUBLICATIONS. — L'Institut a échangé ses publications avec 350 sociétés savantes égyptiennes et étrangères.

BIBLIOTHEQUE. — La Bibliothèque s'est accrue, pendant la session, de 229 volumes par donation et échange ; elle atteint actuellement le chiffre de 40.364 (non compris les périodiques des sociétés savantes).

CONGRES ET CEREMONIES OFFICIELLES. — L'Institut s'est fait représenter aux Congrès internationaux suivants :

a) Ve Congrès international de Sciences Onomastiques, qui s'est tenu à Salamanque au mois d'avril 1955. (M. Charles Kuentz a représenté l'Institut à ce Congrès).

b) VIe Congrès international de Musicologie, qui s'est tenu à Oxford du 29 juin au 4 juillet 1955 (M. le Dr H. Hickmann a représenté l'Institut à ce Congrès).

c) « Deutschen Orientalisten-Kongress », qui s'est tenu à Hambourg du 27 au 31 juillet 1955 (M. le Dr Mohamed Mostafa a représenté l'Institut à ce Congrès).

d) VIIe Congrès international de Papyrologie, qui s'est tenu à Vienne du 29 août au 3 septembre 1955 (M. le Prof. A. Grohmann a représenté l'Institut à ce Congrès).

e) IIe Congrès Arabe de Sciences, qui s'est tenu à Alexandrie du 5 au 12 septembre 1955 (M. Charles Kuentz a représenté l'Institut à ce Congrès).

f) Xe Congrès international d'Etudes Byzantines, qui s'est tenu à Istambul du 15 au 21 septembre 1955 (M. le Dr Bishr Farès a représenté l'Institut à ce Congrès).

D'autre part, l'Institut a été invité au Congrès suivant, auquel il n'a pu se faire représenter :

« Invernational Symposium on Problems of Scientific Research », qui s'est tenu à Milan du 12 au 14 avril 1955.

TABLEAU : — Pendant la session, l'Institut a eu le regret de perdre :

MEMBRES TITULAIRES : G.V. Anrep, S. Mihaeloff.

MEMBRE ASSOCIE : Ugo Monneret de Villard.

ONT ETE ELUS :

MEMBRES TITULAIRES : M. Jean Sainte Fare Garnot, M. le Dr Ahmed Halawani, M. le Prof. Ahmed Riad Tourky.

MEMBRE ASSOCIE : M. Constantin Emil Sander-Hansen.

L'Institut se compose actuellement de :

50 Membres titulaires sur 50 ;
50 Membres associés sur 50 ;
26 Membres correspondants sur 50.

(Voir ci-après p. la liste des membres des trois catégories).

RESULTATS DE L'ANNEE 1954 - 1955
allant du 1er Juillet 1954 au 30 Juin 1955

RECETTES :

En banque le 30 juin 1954	2216,944	
Subvention du Gouvern. Egyptien	3393,200	
Vente de Publications	193,408	
Donations et Publicité	580,—	
Revenus des fonds	8,890	
TOTAL DES RECETTES	6392,442	
(En banque		2206,544
(En caisse		10,—
(Dépôt Cie des Eaux		,400

DEPENSES :

Personnel	1071,750	
Impression	1882,771	
Achat de livres	8,535	
Affranchissements	119,447	
Eau, électricité, téléphone	26,874	
Fournitures (Papeterie)	72,215	
Censeur	20,—	
Fournitures de nettoyage et divers	43,807	
Reliure	49,830	
Aménagements	14,350	
Impôts sur revenus	1,662	
Frais de banque et carnets chèques	5,527	
Reserve : Compte « Indemnités Person ...	1200,—	
Meubles	64,200	
TOTAL DES DEPENSES :	4580,968	
	1811,474	
	6392,442	
(En banque		1801,074
(En caisse		10,—
(Dépôt Cie des eaux		,400
		1811,474

(Dr Fouad Ahmed El-Sawaf) **(Dr I. G. Lévi)**

Le Caire, le 5 décembre 1955.

COMPTE INDEMNITES DU PERSONNEL

Sub/N° 60180

Déposé en banque le 1.7.1954	400,—
Déposé en banque le 11.2.1955	300,—
Déposé en banque le 19.5.1955	500,—
TOTAL	1200,—

Indemnité versée à feu Abdel Samii Mohamed Abdel Wahab El-Maghrabi (Indemnité remise à son père Mohamed Abdel Wahab El-Maghrabi par chèque No. 600726, le 17. 7. 1955)	21,745
Frais de banque (10 + 250 + 50)	310

En banque au 30.6.55	1178,255
En banque	1177,945

(Dr. Fouad Ahmed El-Sawaf) **Dr. I. G. Lévi)**

Le Caire, le 5 décembre 1955.

BUREAU DE L'INSTITUT

POUR L'ANNEE 1955

MM. S. A. HUZAYYIN *président.*
L. KEIMER, SAMI GABRA *vice-présidents.*
Ch. KUENTZ, *secrétaire général.*
I. G. LEVI, *trésorier bibliothécaire.*
J.-Ph. LAUER, *secrétaire adjoint.*

COMITE DES PUBLICATIONS

(OUTRE LES MEMBRES DU BUREAU, QUI EN FONT PARTIE DE DROIT)

MM. R. Cattaui.
O. Guéraud.
M. Jungfleisch.
Moustapha Amer.

LISTE
DES
MEMBRES TITULAIRES DE L'INSTITUT D'EGYPTE
AU 30 JUIN 1955

La date qui suit le nom est celle de la nomination comme membre de l'Institut égyptien ou de l'Institut d'Egypte; le nom du prédécesseur des membres actuels est indiqué entre parenthèses.

1ère Section
LETTRES, BEAUX-ARTS ET ARCHEOLOGIE

LOUTFI EL-SAYED (Ahmed), 6 décembre 1915. (Mgr. Kyrillos Macaire.)
TAHA HUSSEIN, 7 avril 1924. (Ahmed Kamal Pacha.)
KEÏMER (Louis), 1er février 1937. (J.-B. Piot Bey.)
KUENTZ (Charles), 21 février 1938. (P. Lacau.)
SAMI GABRA, 20 janvier 1941. (Ch. de Serionne.)
GUERAUD (Octave), 9 mars 1942. (F. Peter.)
JUNGFLEISCH (Marcel), 6 mars 1944. (G. Foucart.)
CHAFIK GHORBAL (Mohamed), 16 janvier 1947. (Rév. P. P. Sbath.)
HUZAYYIN (Soliman Ahmed), 23 avril 1947. (Ahmed Issa Bey.)
BISHR FARES, 5 avril 1948. (Cheikh Moustapha Abdel Razek.)
MUSTAPHA AMER, 17 mai 1948. (Rév. P. Paul Bovier-Lapierre.)
ROSTEM (Osman Rifki), 14 mai 1949. (D. Pachundaki.)
MOURAD KAMEL, 22 avril 1950 (Togo Mina.)
ANAWATI (R. P. Georges C.), 3 février 1951. (Abdel Meguid Omar Pacha.)
LAUER (JEAN-PHILIPPE), 3 février 1951. M. de Wée.)
GOBY (Jean-Edouard), 22 mai 1952. (J.-I. Craig.)
CHRISTOPHE (Louis A.), 1 mars 1954. (Et. Drioton.)
HICKMANN (Hans), 1 mars 1954. (G. Wiet.)
MOHAMED MOSTAFA, 3 mai 1954. (Mohamed Mahmoud Khalil.)
GARNOT (Jean Sainte Fare), 2 mai 1955. (G. V. Anrep.)

2ème Section
SCIENCES MORALES ET POLITIQUES

LEVI (Isaac G.), 4 décembre 1916. (J. Barois.)
MANSOUR FAHMY, 3 avril 1922. (J. Vaast.)

ARANGIO-RUIZ (Vincenzo), 6 février 1933. (A. Politis.)
GATTAUI (René), 10 février 1941. (W. F. Hume.)
BADAWI (Abdel Hamid), 5 avril 1948. (Farid Boulad Bey.)
MOHAMED KAMEL MOURSY, 26 mai 1951. (Moh. Khalil Abdel Khaleq Bey.)
HAMED ZAKI, 12 janvier 1952. (O. H. Little.)
BADAWY (Helmy Bahgat), 3 mai 1954. (A. Lusena.)

3ème Section
SCIENCES PHYSIQUES ET MATHEMATIQUES

HURST (Harold-Edwin), 5 décembre 1921. (Mohammed Magdi Pacha.)
GHALEB (Kamel Osman), 1er février 1937. (M. Chahine Pacha.)
SIRRY (Hussein), 21 février 1938. (Ismaïl Sirry Pacha.)
MADWAR (Mohamed Reda), 4 mars 1940. (J. Cuvillier.)
RATIB (Ismaïl), 6 décembre 1948. (A. Mochi.)
NAZIF (Moustapha), 22 mai 1952. (Th. de Comnène.)
TOURKY (Ahmed Riad), 4 avril 1955. (S. Mihaeloff.)

4ème Section
MEDECINE, AGRONOMIE ET HISTOIRE NATURELLE

WILSON (William-Hawkins), 7 décembre 1908. (Commandant Léon Vidal.)
SOBHY (Gorgi), 3 février 1936. (A. Zaki Pacha.)
AVIERINOS (Christo), 6 mars 1944. (Th. Papayoannou.)
KAMEL HUSSEIN (Mohamed), 2 avril 1945. (P. Kraus.)
SOBHY (Mohamed), 11 mars 1946. (M. Meyerhof.)
ATTIA (Mahmoud Ibrahim), 4 février 1946. (G. Ferrante.)
ALFIEI (Anastase), 6 mars 1947. (U. Ricci.)
HUSSEIN FAOUZI, 8 mars 1948. (Ali Pacha Ibrahim.)
MOSSERI (Henri V.), 8 mars 1948. (A. Lucas.)
GODEL (Roger), 5 avril 1948. (L. Balls.)
BALOG (Paul), 19 novembre 1949. (A. Sammarco.)
EFFLATOUN (Hassan Chaker), 3 février 1951. (Ali Moustapha Mosharrafa Pacha.)
GHALIONGUI (Paul), 22 mai 1952. (G. W. Murray.)
GREISS (Elhamy), 1 mars 1954. (Saadallah Madwar.)
HALAWANI (Ahmed), 4 avril 1955. (J. A. Boyé.)

LISTE
DES
MEMBRES ASSOCIES
AU 30 JUIN 1955

MM. MRAZEK (Louis), 19 janvier 1914.
DE VREGILLE (Rév. P. Pierre), 14 janvier 1918.
BRUMPT (Emile), 7 janvier 1924 (Paris).
BARTHOUX (Jules), 12 janvier 1925 (Paris).
CHARLES-ROUX (François), 12 janvier 1925 (Paris).
JONDET (Gaston), 11 janvier 1926 (Dreux).
FLEURI (Gaston), 17 janvier 1927 (Bécon-Asnières-Seine).
LALANDE (André), 9 janvier 1928 (Asnières, Seine).
ARVANITAKIS (Georges), 13 mai 1929 (Athènes).
LOTSY (Gerhard-Oswald), 4 mai 1931 (Casablanca).
POLITIS (Athanase G.), 9 mai 1932.
ROYER (Etienne), 1er mai 1933 (Mandelieu, Alpes Maritimes).
BRECCIA (Evaristo), 7 mai 1934 (Rome).
LACAU (Pierre), 10 mai 1937 (Paris).
GHIGI (Alessandro), 21 février 1938 (Bologne).
HADAMARD (Jacques), 21 février 1938 (Paris).
GROHMANN (Adolf), 21 février 1938 (Le Caire).
ANDREAE (Charles), 21 février 1938 (Zurich).
CUVILLIER (Jean), 5 décembre 1938 (Paris).
BELL (arold-Idris), 4 mars 1940 (Aberystwyth).
DONTAS (Spiro), 4 mars 1940 (Athènes).
GERULANOS (Marius), 4 mars 1940 (Athènes).
MINOST (Emile), 13 mai 1946 (Paris).
Van WIJNGAARDEN (Williem-Dirk), 5 février 1947 (Leide).

MM. GIBB (Hamilton - Alexander - Rosskeen), 5 février 1947 (Oxford).
LEFEBVRE (Gustave), 5 février 1947 (Versailles).
VOLTERRA (Edouardo), 5 février 1947 (Bologne).
MASSIGNON (Louis), 5 février 1947 (Paris).

GARDINER (Sir Alan H), 5 février 1947 (Oxford).
CERNY (Jaroslav), 9 février 1948 (Oxford).
BARRIOL (Alfred), 9 février 1948 (Paris).
BALLS (Lawrence), 5 avril 1948 (Cambridge).
FLEURE (Herbert-John), 4 février 1950 (Londres).
LITTLE (Otway Henry), 20 mai 1950 (Cape Province).
WEE (Maurice de), 20 mai 1950 (Bruxelles).
DAWSON (Warren Royal), 3 février 1951 (Bucks).
HASSAN HOSNI ABDEL WAHAB, 3 février 1951 (Tunis).
JANSSEN (Jozef), 3 février 1951 (Leide).
MONTET (Pierre), 3 février 1951 (Paris).
GARcia GOMEZ (Emilio), 19 février 1952 (Madrid).
VAUFREY (Raymond), 19 février 1952 (Paris).
MURRAY (George William Welch), 19 février 1952 (Aberdeenshire).
DRIOTON (Etienne), 2 novembre 1953 (Montgeron).
WIET (Gaston), 2 novembre 1953 (Paris).
MILES (George, Carpenter), 8 février 1954 (New York).
MONTEL (Paul), 8 février 1954 (Paris).
PORTEVIN (Albert, Marcel, Germain, René), 8 février 1954 Saint Germain el-Layer).
Van DE WALLE (Baudouin), 8 février 1954 (Bruxelles).
BOYE (André-Jean), 6 décembre 1954 (Bordeaux).
SANDER-HANSEN (Constantin, Emil), 7 février 1955. (Copenhague).

LISTE
DES
MEMBRES CORRESPONDANTS
AU 30 JUIN 1955

MM. FODERA (F.), 9 novembre 1900.
CALLIMACHOS (Demètre), 9 janvier 1912.
DALLONI (Marius), 10 février 1936 (Alger).
DESIO (Ardito), 10, février 1936 (Milan).
DOLLFUS (Robert Ph.), 10 février 1936 (Paris).
LEIBOVITCH (Joseph), 10 février 1936 (Jérusalem).
Doncieux (Louis), 1er février 1937.
MONNEROT - DUMAINE (Marcel), 4 mras 1940 (Port-Saïd).
JABES (Raymond), 6 mars 1947 (Paris).
DORESSE (Jean), 19 février 1949.
SEELE (Keith C.), 19 février 1949 (Chicago).
BRESCIANI TURRONI (Costantino), 4 février 1950 (Milan).
FONTAINE (Alfred L.), 4 février 1950 (Ismaïlia).
ABDEL FATAH HELMY, 3 février 1951 (Le Caire).
ABDEL MOHSEN EL-KHACHAB, 3 février 1951 (Le Caire).
ABDEL NABI EL-NAHAS, 3 février 1951 (Le Caire).
EL-MOUELHY (Ibrahim), 3 février 1951 (Le Caire).
MICHAILIDIS (Georges), 3 février 1951 (Le Caire).
MOHAMED MAHDI, 3 février 1951 (Le Caire).
SCHWARTZ (Jacques), 3 février 1951 (Strasbourg).
FRIEDINGER - PRANTER (Robert), 19 février 1952 (Vienne).
ABDEL - RAHMAN ZAKI, 19 février 1952 (Le Caire).
BADAWY (Alexandre), 19 février 1952 (Le Caire).
GANDILHON (René), 8 février 1954 (Chalon-sur-Marne).
ABDEL ZAHAB (Hassan), 8 février 1954 (Le Caire),
KOMORZYNSKI (Egon), 8 février 1954 (Wien).

محاضر الجلسات

الجلسة العلنية
المنعقدة فى يوم الاثنين الموافق ٩/٤/١٩٥٦

عقد الاجتماع فى الساعة ٦ مساء بدار المجمع بحضور السادة الأساتذة والدكاترة :

الدكتور سليمان حزين	الرئيس
المسيو شارل كونس	السكرتير العام
الدكتور ا . ج . ليفى	أمين الصندوق والمكتبة
المسيو ح . ف . لاوير	السكرتير المساعد

واعتذر الأستاذان كيمر وسامى جبره نائبا الرئيس

أعضاء عاملون : افرينوس . بالوج . بشر فارس . رينيه قطاوى . كريستوف . جوبى . كامل عثمان غالب . غاليونجى . إلهامى جريس . محمد مدور . محمد مصطفى . اسماعيل راتب .

أعضاء مراسلون : عبد الرحمن زكى . حسن عبد الوهاب .

المدعوون : مدام انرب . مدام بالوج . السادة عيروط . سند بسطا . برك . سركا . هويل . رياض حجازى . ابراهيم فرج . محمود السبع . محمد محمود غالى . بوزى . رشاد . يسى عبد المسيح .

١ — قرأ السكرتير العام محضر جلسة ٥ مارس ١٩٥٦ ثم ووفق عليه .

٢ — عرض السكرتير العام العدد الجديد من المجلة جزء ١ من المجلد ٣٧ ، وكذلك الأبحاث المهداة إلى المجمع من السادة بشر فارس وليفوبر وأندريه ، وقد شكرهم الرئيس .

٣ ـ ألقى الدكتور بشر فارس محاضرته عن « كيف زوقت العرب كتب الفقه والفلسفة » .

٤ ـ قرأ السيد حسن عبد الوهاب محاضرته عن « الآثار المنقولة والمنتحلة »

وقد أبديت بعض الملاحظات من السادة : محمود السبع وعبده شطا ومحمد محمود غالى .

وقد شكر الرئيس المحاضر على محاضرته الممتعة المدعمة بالمستندات .

٥ ـ ألقى الدكتور رياض حجازى محاضرته عن « أنواع الرسوبيات المصرية ودلالتها على الهزات الأرضية .

وانتهى الاجتماع فى الساعة الثامنة وعشر دقائق مساء .

السكرتير العام

ش . كونس

ملخص المحاضرات

التى ألقيت بجلسة يوم الإثنين ١٩٥٦/٤/٩

١) الدكتور بشر فارس : كيف زوّقت العرب كتب الفلسفة والفقه [1] .

قدم المحاضر منمنمتين إحداهما تزوّق فاتحة نسخة من « رسائل اخوان الصفا وخلان الوفا » محفوظة فى استانبول والأخرى تزين مخطوطاً فقد جسمه ، عنوانه « كتاب قواعد الأحكام فى معرفة الحلال والحرام » تصنيف العلامة الشيعى جمال الدين الحسين (أو الحسن) بن يوسف بن على بن المطهر الحلى (٦٤٨ ـ ٧٢٦ هـ / ١٢٥٠ ـ ١٣٢٥م) وهى فى مجموعة أحد عشاق النفائس فى مدينة كان بفرنسا .

وقد أنجزت المنمنمة الأولى فى دار السلام سنة ٦٨٦ هـ / ١٢٨٧ م ، وأما الثانية فالمرجع إنها دبجت فى الشطر الأول من القرن الثامن الهجرى فى بلد ناء عن انرابات الفن الذى هجم على البلدان العربية من جهة الشرق الأقصى بعد سقوط بغداد .

(١) لم تطبع .

والتصويرتان جميعاً تنتسبان إلى النمط البغدادى فى التزويق والتأليف والتلوين وبهذا تزيدان فى عقد الصلة بين المنمنمات العربية الأولى والمتأخرة ، ولكلتا الوثيقتين شأن عظيم ، ذلك لأسباب نجتزىء بهذين : لأول مرة نعثر على تصويرة تزين كتاباً فى الفلسفة ، وأخرى تحلى كتاباً فى الفقه وهذه الأخيرة أذهب فى الغرابة ، فى تصويرة « الرسائل » يبرز إخوان الصفا الخمسة الذين ألفوها وفى « القواعد » يبرز مصنفها العلامة بن المطهر .

٢) السيد حسن عبد الوهاب : الآثار المنقولة والمنتحلة .

بحث تناول العناصر الغريبة المنقولة إلى العمارة الإسلامية بمصر ما بين عمد وتيجان مصرية وقبطية وكتابات هيروغليفية . كما يتناول أيضاً العناصر المنقولة من قصور ومساجد إلى مساجد أخرى ثم الآثار المنتحلة ، إما بنسبتها إلى غير منشئيها أو بالتزوير فى نصوصها التاريخية .

٣) الدكتور رياض حجازى والدكتور إبراهيم فرج :
أنواع الرسوبيات المصرية ودلالتها على الهزات الأرضية فى العصور الجيولوجية المختلفة بالقطر المصرى .

نوقشت أنواع الرسوبيات المصرية فى العصور الجيولوجية المختلفة ووجدت كالآتى :

١ ـ صخور مصر الرسوبية فى حقب ما قبل الكمبرى متحولة وهى بوجه عام اردوازية أو جريواك وكونجلومرات تابعة لرسوبيات الجيوسينكلين ودالة على هزات أرضية عنيفة نسبياً حدثت فى هذا الحقب .

٢ ـ رسوبيات حقبى الحياة القديمة والحياة المتوسطة أساسياً أحجار جيرية وأخرى رملية من نوع الأرثوكوارتزيت وتابعة لرسوبيات البلاتفورم ودالة على استقرار القشرة الأرضية فى القطر المصرى فى هذين الحقبين وتعرضها لعمليات من التعرية على نطاق واسع .

٣ ـ رسوبيات الحقب الثلاثى مزيج من رسوبيات تابعة للبلاتفورم

وأخرى كونجلو مراتية دالة على استقرار يرافقه هزات أرضية بسيطة نسبياً حدثت بين الآن والآخر أثناء هذا الحقب فى العصور الآتية :

الطباشيرى — الأيوسين ، فجر الأيوسين المتوسط ، آخر الأيوسين المتوسط ، آخر الأيوسين الأعلى ، الأوليجوسين ، آخر الأوليجوسين ، فجر الميوسين ، آخر الميوسين المتوسط ، آخر الميوسين — فجر البليوسين — آخر البليو سين .

محاضر الجلسات

الجلسة العلنية فى ٢٣ أبريل سنة ١٩٥٦

عقد الاجتماع بدار المجمع العلمى المصرى فى الساعة ٩ مساء بحضور السادة المحترمين :

الأستاذ سامى جبره	نائب الرئيس
الأستاذ ل . كيمر	نائب الرئيس
الدكتور ليفى	أمين الصندوق والمكتبة
المسيو لاوير	السكرتير المساعد

واعتذر الرئيس الدكتور سليمان حزين والسكرتير العام المسيو كونس

أعضاء عاملون : بالوج . قطاوى . جان سنت فارجارنو . جريس .
واعتذر كامل عثمان غالب . وجوبى .

أعضاء مراسلون : عبد الرحمن زكى

المدعـوون : مدام بالوج . مدام كيللر . مدام بونوجريناد . مدموازيل كانالاس . السـادة محمد يوسف حسن . محمد محمود اسماعيل . مراد ابراهيم . بانينج . أمير راشويلتز . سونيرون . عبده شطا . وايلد . يحيى أنور . يويوتى .

١ — قرأ السكرتير المساعد محضر جلسة ٩ / ٤ / ٥٦ ثم ووفق عليه .

٢ — عرض السكرتير المساعد البحث المهدى للمجمع من السيد كريستوف وقدم له الشكر .

٣ — القي الأستاذ كيمر محاضرته عن « فى أى العصور انقرضت الحيوانات المفترسة من مصر »

وابدى المسيو فارجارنو بعض الملاحظات .

٤ ـ القى الدكتور محمد يوسف حسن محاضرته عن « مكان طبقات تسيتل أو الأوفرفيجيششتن من ستراتيجرافية . . »

٥ ـ القى الدكتور عبده شطا محاضرته عن « توزيع صخور العصر الايوسينى فى شبه جزيرة سيناء »

وانتهى الاجتماع فى الساعة العاشرة والدقيقة ٤٠ مساء .

السكرتير المساعد

ملخص المحاضرات

التى ألقيت بجلسة الاثنين ٢٣ / ٤ / ١٩٥٦

١) الأستاذ ل . كيمر : فى أى العصور انقرضت الحيوانات المفترسة من مصر ؟

كانت مصر موطناً لأنواع كثيرة مختلفة من الحيوانات المفترسة . ولكن هذه الحيوانات بدأت تنقرض فى عصور ما قبل التاريخ .

وموضوع هذه المحاضرة هو الكلام عن التواريخ التقريبية لانقراض كل نوع من هذه الأنواع حتى الآن .

٢) الدكتور محمد يوسف حسن : مكان طبقات تسيتل أو الاوفرفيجيششتن من ستراتجرافية المرحلة السنونية العليا

كان الوضع المعروف حتى الآن لجميع الطبقات للصخور النميوليتية فيما عدا طبقات طفل اسنا السفلى فى الواحات الخارجة وجنوب الصحراء الغربية عموماً هو أنها تابعة للمرحلة الدانية .

وفى هذا البحث يدلنا التحليل المفصل للحفريات الموجودة فى هـــذه الصخور « الأوفرفيجيششتن » وكذلك مقارنتها بحفيات التكاوين المشابهة انها تتبع المسترختيانية وتشبه فى ذلك على الأخص تكاوين تلك المرحلة فى المرحلة الهندوباسيفيكية . وقد مكن هذا البحث كذلك من تقسيم هذه الصخور إلى ثلاث مستويات كل واحد يتميز بمجموعة مميزة من الحفريات وهذه المستويات كالآتى :

المستوى « ج » ويتميز بالحفرية « كارديتا ليبيكا » (كواس)

المستوى «ب» « « أكسوجيرا أوفرفيجى « فون بوخ »

المستوى « ا » « « ايسوكارديا خارجنسين « ماير ـ ايمار .

٣) الدكتور عبده شطا : توزيع صخور العصر الأيوسينى فى شبه جزيرة سيناء

عند فحص الخريطة الجيولوجية للقطر المصرى التى نشرتها المساحة أخيراً يلاحظ أن المساحة التى تغطيها الطبقات التابعة للعصر الأيوسينى أقل من الواقع بقدر كبير وهذا يرجع إلى سببين أساسيين :

أولا ـ أن بعض المناطق التى تظهر فيها هذه الطبقات تبدو مغطاة بالرواسب الحديثة .

ثانياً ـ فى بعض المناطق الأخرى تظهر طبقات الأيوسين وكأنها تابعة للعصر الطباشيرى .

والغرض من هذا البحث هو تحديد التوزيع الفعلى لطبقات الأيوسين فى سيناء ورسم العلاقة بين الأقســام المختلفة . وتبنى هذه المعلومات على خبرتى السابقـــة فى المنطقة وعلى الاتصال الشخصى ببعض الجيولوجيين فى شركات البترول والجامعات .

TABLE GENERALE DES MATIERES

(Fascicule 1)

PROCES-VERBAUX



مجلة

المجمع العلمي المصري

المجلد الثامن والثلاثون

الجزء الأول

(١٩٥٥ - ١٩٥٦)

القاهرة

مطبعة كوستاتسوماس وشركاه
٥ شارع وقف الخربوطلي . الظاهر تليفون ٤٤١١٨